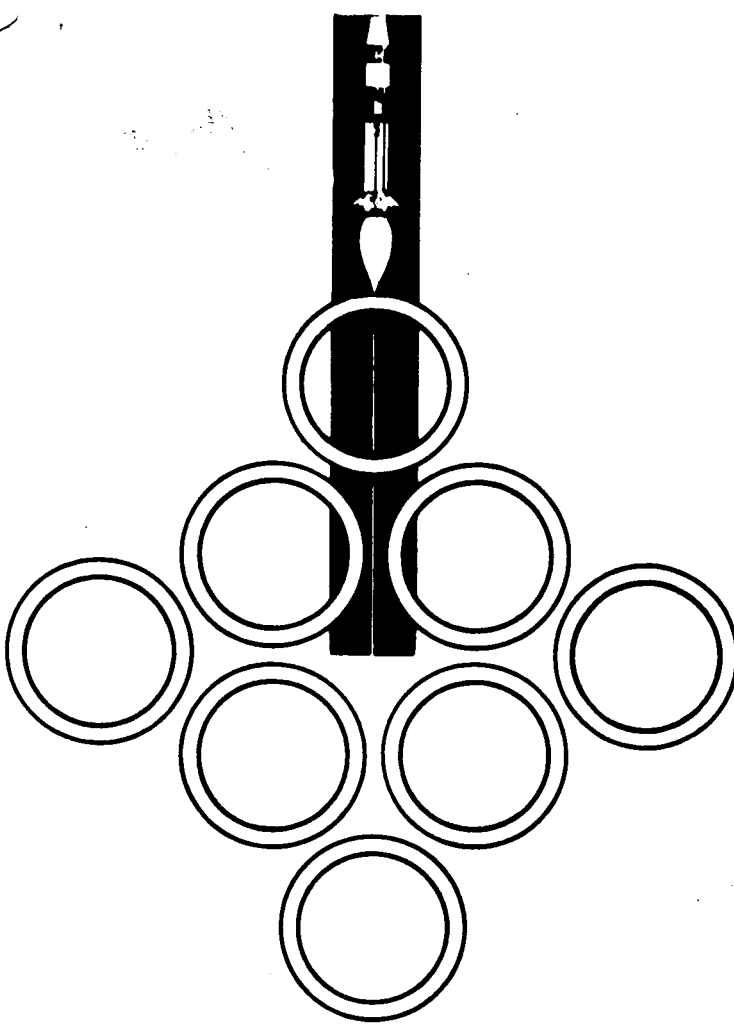


ENGINEERING DEPARTMENT  
TECHNICAL REPORT

TR-RE-CCSD-FO-1031-3

January 16, 1967

SATURN IB PROGRAM



TEST REPORT  
FOR

BUTTERFLY VALVE, 6-INCH, 300-PSIG

Hadley Valve Company Model Number 11953-6

NASA Drawing Number 75M13141 LSOV-2

N67-26292

FACILITY FORM 60

(ACCESSION NUMBER)

(THRU)

79  
(PAGES)

5  
(CODE)

CR-84043  
(NASA CR OR TMX OR AD NUMBER)

15  
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SPACE DIVISION



CHRYSLER  
CORPORATION

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U.S. DEPARTMENT OF COMMERCE  
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INFORMATION SERVICE  
SPRINGFIELD, VA 22161

TEST REPORT  
FOR  
BUTTERFLY VALVE, 6-INCH, 300-PSIG  
Hadley Valve Company Model Number 11953-6  
NASA Drawing Number 75M13141 LSOV-2

ABSTRACT

This report presents the results of tests performed on two test specimens of Butterfly Valve 75M13141 LSOV-2. The following tests were performed:

- |                         |               |
|-------------------------|---------------|
| 1. Receiving Inspection | 6. Surge      |
| 2. Proof Pressure       | 7. Icing      |
| 3. Functional           | 8. Salt Fog   |
| 4. Temperature Shock    | 9. Life Cycle |
| 5. Vibration            |               |

The butterfly valve met the requirements of NASA drawing 75M13141 LSOV-2 throughout the test program.

TEST REPORT

FOR

BUTTERFLY VALVE, 6-INCH, 300-PSIG

Hadley Valve Company Model Number 11953-6

NASA Drawing Number 75M13141 LSOV-2

January 16, 1967

## FOREWORD

The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under contract NAS8-4016, Part VII, CWO 271620.

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# CHECK SHEET

FOR

## BUTTERFLY VALVE, 6-INCH, 300-PSIG

MANUFACTURER: Hadley Valve Company, Pomona, California

MANUFACTURER'S MODEL NUMBER: 11953-6

NASA DRAWING NUMBER: 75ML3141 LSOV-2

TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana

AUTHORIZING AGENCY: NASA KSC

### I. FUNCTIONAL REQUIREMENTS

- |                        |  |
|------------------------|--|
| A. OPERATING MEDIUM:   | Flow chamber - LN <sub>2</sub> , GN <sub>2</sub><br>Actuator - GN <sub>2</sub> |
| B. OPERATING PRESSURE: | Flow chamber - 300 psig<br>Actuator - 750 psig                                 |
| C. FLOW CAPACITY:      | C <sub>v</sub> = 1600 minimum  |
| D. ALLOWABLE LEAKAGE:  | Internal - 300 sccm at -320°F<br>6 sccm at room ambient temperature            |
| E. VALVE OPERATION:    | Pneumatically operated, normally closed  |

### II. CONSTRUCTION

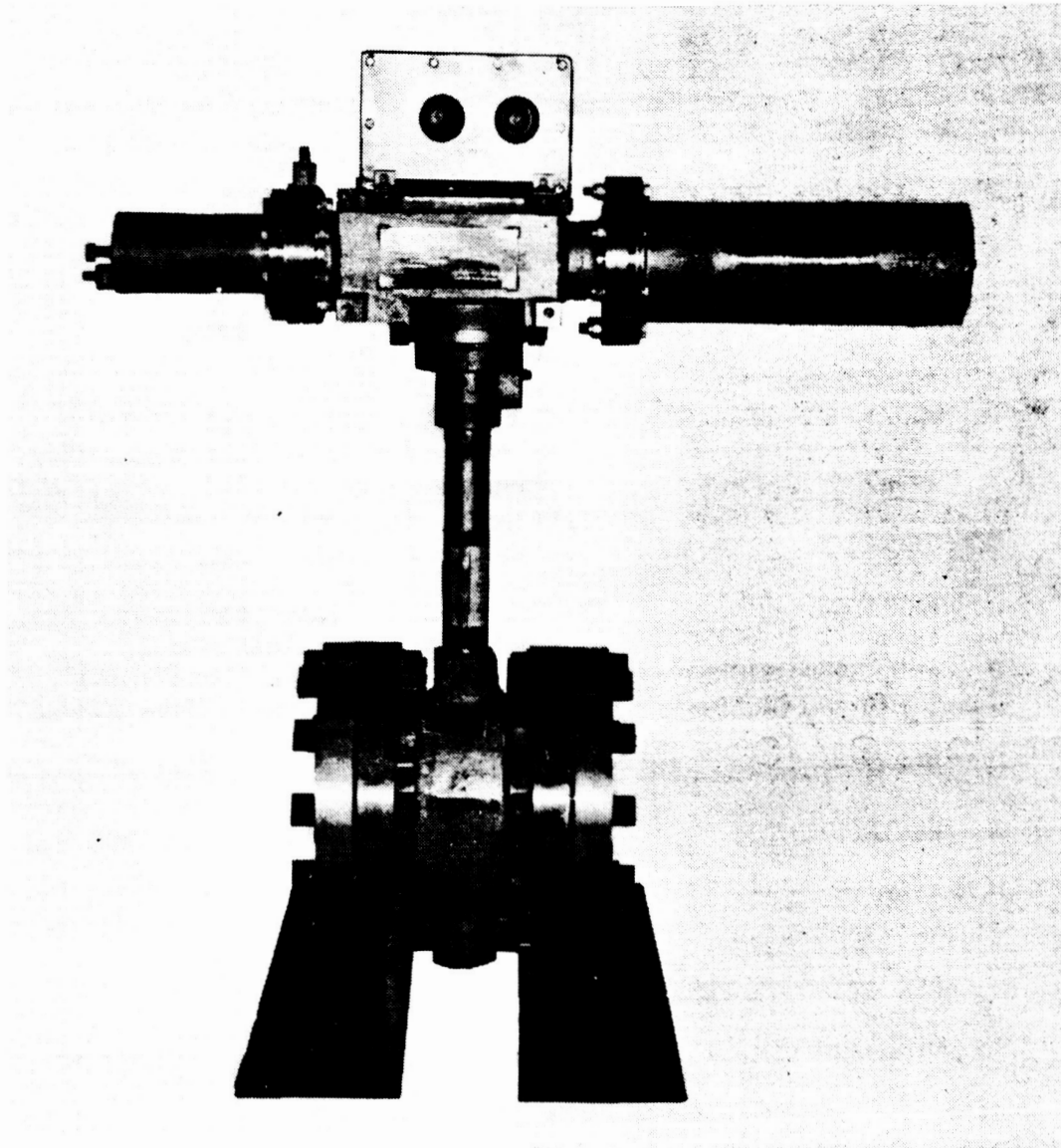
- |                     |   |
|---------------------|---|
| A. MATERIAL:        | All metallic valve components are<br>austenitic stainless steel |
| B. END CONNECTIONS: | 300-lb ASA flanges (both ends)                                  |
| C. LIMIT SWITCHES:  | Minneapolis-Honeywell Type EXH-AR7                              |

### III. ENVIRONMENTAL REQUIREMENTS

- |                           |  |
|---------------------------|--|
| A. ENVIRONMENTS:          | Temperature Shock<br>Vibration<br>Surge<br>Icing<br>Salt Fog |
| B. OPERATING TEMPERATURE: | +125 to -320°F   |

### IV. LOCATION AND USE:

Used in the liquid oxygen systems as a shutoff valve in the S-IB and S-IVB main fill and drain lines at Launch Complexes 34 and 37.



Butterfly Valve, 6-Inch, 300-psig  
75M13141 LSOV-2

TEST SUMMARY  
BUTTERFLY VALVE  
75M13141 LSOV-2

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Receiving Inspection	2	Compliance with Vendor and NASA drawings	Determine if Specimen complies with drawings and check for defects and poor workmanship	Satisfactory	None
Proof Pressure	2	Actuator pressure: 1125 psig Flow chamber pressure: 450 psig	Verify that test specimen will withstand test pressures without leakage or distortion	Satisfactory	None
Functional	2	Allowable Leakage: Internal - 6 sccm at room temperature External - None  Allowable response 2 seconds Insulation resistance: 20 megohms min.	Determine if test specimen will operate satisfactorily prior to environmental exposure	Satisfactory	None
Temperature Shock	1	High temperature: 125°F Low temperature: -320°F	Determine if test specimen will operate satisfactorily after exposure to temperature shock conditions.	Satisfactory	None
Vibration	1	See section IV for vibration levels	Determine if test specimen will operate satisfactorily after exposure to vibration	Satisfactory	None
Surge	1	0 to 300 psig within 100 milliseconds	Determine if test specimen will operate satisfactorily after being subjected to 1000 surge cycles	Satisfactory	None
Icing	1	Formation of a minimum of $\frac{1}{8}$ -inch of ice on the test specimen	Determine if test specimen will operate satisfactorily with the formation of a minimum of $\frac{1}{8}$ inch of ice	Satisfactory	None
Salt Fog	1	240 hours of salt fog conditions	Determine if test specimen will operate satisfactorily after exposure to salt fog conditions	Satisfactory	Some rust and corrosion were present on the test specimen upon completion of the salt fog test. This, however, is considered acceptable.
Cycle	2	1000 opening and closing cycles	Determine if test specimen will operate satisfactorily after 1000 opening and closing cycles	Satisfactory	None

## SECTION I

### INTRODUCTION

#### 1.1 SCOPE

This report presents the results of tests performed to determine if pneumatically operated Butterfly Valve 75M13141 LSOV-2 meets the operational and environmental requirements for John F. Kennedy Space Center Launch Complexes 34 and 37. A summary of the test results is presented on page ix.

#### 1.2 ITEM DESCRIPTION

1.2.1 Two specimens of Butterfly Valve 75M13141 LSOV-2 were tested. The valve is used in the liquid oxygen systems as a shutoff valve in the S-IB and S-IVB main fill and drain lines.

1.2.2 The valve is manufactured by Hadley Valve Company as vendor model number 11953-6. The overall dimensions of the valve are 8 inches between flanges and 34.48 inches from the bottom of the flow chamber to the top surface of the switch enclosure. It is a normally closed valve having a 6-inch flow chamber and is maintained in the closed position by compression springs. The valve is operated by a pneumatic actuator at 750 psig. Indicating switches are incorporated for monitoring the butterfly position. The valve is designed for use with LN<sub>2</sub> or LOX.

#### 1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Butterfly Valve 75M13141 LSOV-2.

- a. KSC-STD-164(D), Standard Environmental Test Methods
- b. 75M13141 LSOV-2 NASA Drawing
- c. MSFC-STD-164(D), Cleaning Standard
- d. Test Plan CCSD-FO-1031-1R, Test Requirements

SECTION II  
RECEIVING INSPECTION

2.1        TEST REQUIREMENTS

Each specimen shall be visually and dimensionally inspected for conformance with applicable specifications prior to testing.

2.2        TEST PROCEDURE

2.2.1      A visual and dimensional inspection of each specimen was performed to determine compliance with NASA drawing 75M13141 ISOV-2 and the applicable vendor drawing to the extent possible without disassembly of the specimen. At the same time each test specimen was also inspected for poor workmanship and manufacturing defects.

2.2.2      One test specimen was weighed and the weight was recorded.

2.3        TEST RESULTS

Each test specimen was in compliance with NASA drawing 75M13141 ISOV-2 and the applicable vendor drawing. No evidence of poor workmanship or manufacturing defects was observed.

2.4        TEST DATA

The data presented in table 2-1 were recorded during the inspection.

Table 2-1. Specimen Specifics

Name	Butterfly Valve
Manufacturer	Hadley Valve Company
Model Number	11953-6
End Connections	300-lb ASA flanges
Limit Switches	Minneapolis-Honeywell EXH-AR7
Dimensions	8-inches between flanges, 34.48 inches overall height
Weight	246 pounds

SECTION III  
PROOF PRESSURE TEST

3.1        TEST REQUIREMENTS

- 3.1.1      Each valve shall be subjected to a GN<sub>2</sub> pressure of 450 psig for 5 minutes.
- 3.1.2      Each actuator shall be subjected to a GN<sub>2</sub> pressure of 1125 psig for 5 minutes.
- 3.1.3      Each specimen valve and actuator shall be monitored for external leakage and distortion during these tests, external leakage and distortion shall be noted.

3.2        TEST PROCEDURE

- 3.2.1      The proof pressure test setup was assembled as shown in figures 3-1 and 3-2 using the equipment listed in table 1. It was determined that hand valve 11 was closed and all other hand valves were opened.
- 3.2.2      Regulator 5 was adjusted to provide GN<sub>2</sub> at 450 psig to the test specimen inlet.
- 3.2.3      Hand valve 6 was closed to isolate the system and regulator 5 was vented.
- 3.2.4      The pressure was monitored for 5 minutes, and the specimen was checked for internal and external leakage by observing flowmeter 9 and pressure gage 8.
- 3.2.5      Hand valve 6 was opened to vent the system.
- 3.2.6      Hand valve 6 was closed and all other hand valves were opened.
- 3.2.7      Regulator 10 was adjusted to provide GN<sub>2</sub> at 1125 psig to the actuator.
- 3.2.8      Hand valve 11 was closed to isolate the system and regulator 10 was vented.
- 3.2.9      The specimen was checked for external leakage by observing pressure gage 13 for 5 minutes.
- 3.2.10     Hand valve 11 was opened to vent the system.
- 3.2.11     Solenoid valves 16 and 17 were energized to allow pressure to be applied to the other side of the actuator.
- 3.2.12     Regulator 10 was adjusted to provide GN<sub>2</sub> at 1125 psig to the actuator.

- 3.2.13 Hand valve 11 was closed to isolate the system, and regulator 10 was vented.
- 3.2.14 The pressure was monitored for 5 minutes, and the specimen was checked for external leakage by observing pressure gage 13.
- 3.2.15 Hand valve 11 was opened to vent the system.
- 3.2.16 The specimen was checked for damage and distortion.

3.3 TEST RESULTS

The test specimen did not leak, and there was no evidence of damage.

3.4 TEST DATA

The data presented in table 3-2 were recorded during the test.

Table 3-1. Proof Pressure Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Hadley Valve Co.	11953-6	1 and 2	Butterfly valve, 6-inch, 300-psig
2	Hand Valve*	Hoke	NA	NA	1/4-inch
3	Pressure Gage	Ashcraft	NA	NA	0-to 5500-psig Cal. date 9-6-66
4	Filter	Bendix	1731260	570015	10-micron nominal 5-micron absolute
5	Pressure Regulator*	Marotta	NA	NA	
6	Hand Valve*	Hoke	NA	NA	1/4-inch
7	Hand Valve*	Hoke	NA	NA	1/4-inch
8	Pressure Gage*	Heise	NA	NA	0-to 1000-psig Cal. date 9/6/66
9	Flowmeter	Fisher Porter	NA	200595 E thru H	
10	Pressure Regulator*	Tescom	NA	NA	
11	Hand Valve*	Hoke	NA	NA	1/4-inch
12	Hand Valve*	Hoke	NA	NA	1/4-inch
13	Pressure Gage*	Heise	NA	NA	0-to 3500-psig Cal. date 9/6/66
14	Switch*	Minneapolis Honeywell	NA	NA	SPST
15	Switch*	Minneapolis Honeywell	NA	NA	SPST
16	Solenoid Valve	Marotta	MV-74	819	2-position, 3-way
17	Solenoid Valve	Marotta	MV-74	824	2-position, 3-way

\* This part is a component of cryogenic test console 200586 (NASA special equipment)

Table 3-1. Proof Pressure Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
18	Power Supply		NA	NA	28-vdc
19	GN <sub>2</sub> Source		NA	NA	

Table 3-2. Proof Pressure and Leakage

Specimen No.	1	2
Valve Seat Leakage	0	0
External Leakage	None	None
Damage or Distortion	None	None



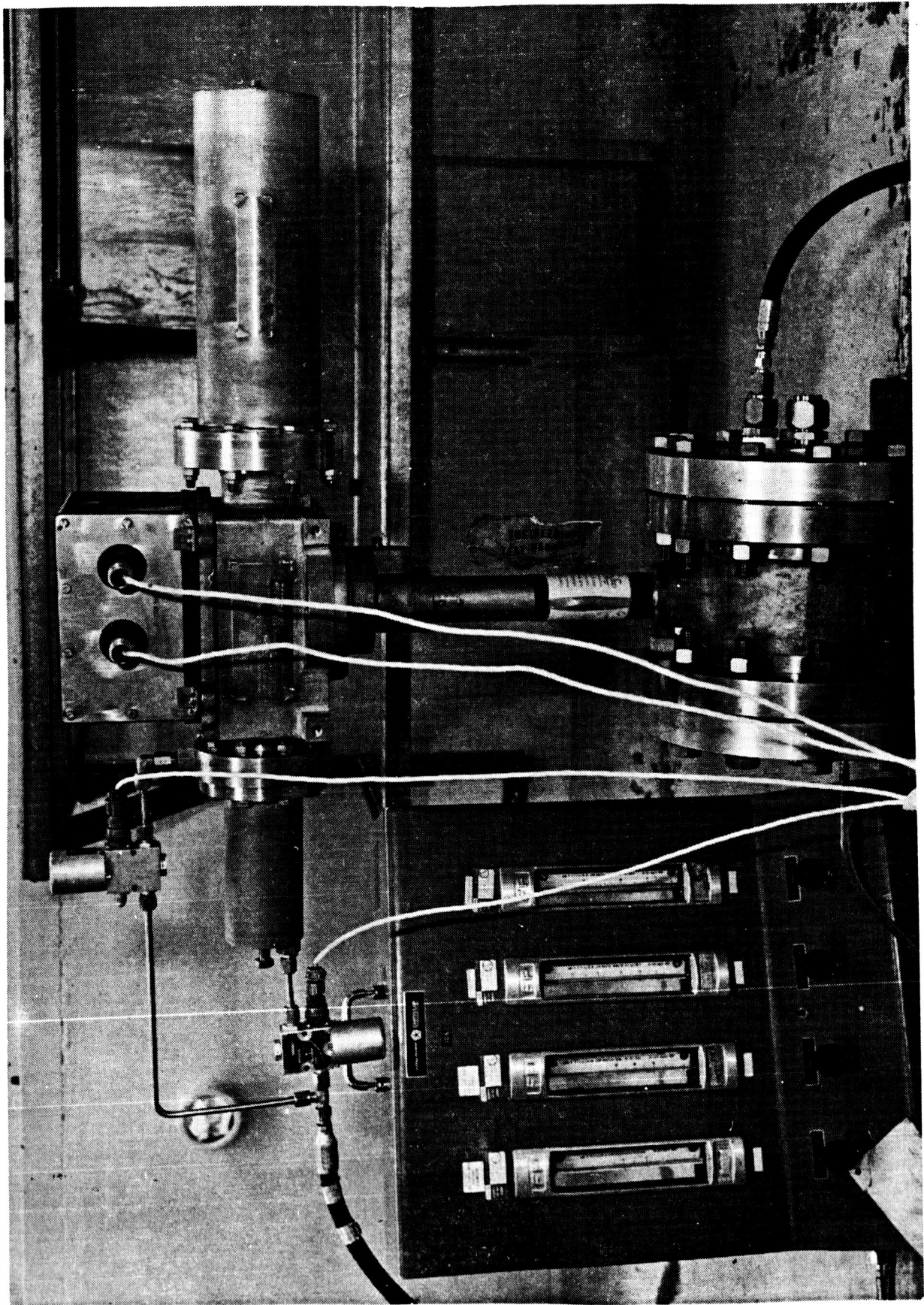


Figure 3-2. Proof Pressure Test Setup

SECTION IV  
FUNCTIONAL TEST

4.1        TEST REQUIREMENTS

4.1.1        The position-indicating switches shall be monitored during each step of the functional test.

4.1.2        The test specimen shall be cycled from the open to the closed to the open positions 10 times before testing. This process shall be continued during the initial functional test only.

4.1.3        VALVE LEAKAGE AND RESPONSE (GN<sub>2</sub>)

4.1.3.1        Valve Internal Seat Leakage. With the specimen in the closed position, the valve seat leakage shall be measured for 5 minutes. Ambient GN<sub>2</sub> at 750 psig shall be applied to the actuator and ambient GN<sub>2</sub> at 300 psig applied to the valve inlet. The maximum allowable leakage in each case is 6 sccm. This test shall be conducted during the initial functional test only.

4.1.3.2        Valve Response. The response time of the specimen shall be measured while the specimen is being cycled from the closed to the open position and from the open to the closed position with ambient GN<sub>2</sub> at 300 psig applied to the valve inlet and GN<sub>2</sub> at 750 psig applied to the actuator. The maximum response time allowed for full opening or closing in each case is 2 seconds. This test shall be conducted during the initial functional test only.

4.1.3.3        External Leakage. External leakage shall be checked, when possible, by leakage detection solution with the specimen pressurized with GN<sub>2</sub> at 300 psig on the valve inlet and the actuator pressurized with GN<sub>2</sub> at 750 psig during a 30-minute interval. There shall be no leakage. This test shall be conducted during the initial functional test only.

4.1.4        VALVE LEAKAGE AND RESPONSE (LN<sub>2</sub>)

4.1.4.1        Valve Internal Seat Leakage. Procedures described in 4.1.3.1 shall be repeated except the valve specimen shall be pressurized with LN<sub>2</sub>. The maximum allowable leakage at -320°F is 300 sccm.

4.1.4.2        Valve Response. Repeat procedures described in 4.1.3.2 except the valve specimen shall be pressurized with LN<sub>2</sub>.

4.1.4.3        External Leakage. Repeat procedures described in 4.1.3.3 except the valve specimen shall be pressurized with LN<sub>2</sub>.

4.1.4.4        Loss of Actuator Pressure Response. The valve specimen closing response time shall be measured when the actuator pressure is suddenly reduced to zero psig. The valve specimen inlet shall be pressurized to 300 psig with LN<sub>2</sub>.

The insulation resistance of the position-indicating switches shall be measured between each terminal and the case and between all nonconnected terminals. The minimum resistance allowed is 20 megohms with 500 vdc applied for 60 seconds. This test shall be conducted during the initial functional test only, unless otherwise indicated.

## 4.2

TEST PROCEDURE

## 4.2.1

The functional test setup was assembled as shown in figures 4-1 and 4-2 using the equipment listed in table 4-1. The position-indicating switches were monitored throughout the test.

## 4.2.2

Hand valves 6 and 7 were closed and all other hand valves were opened. Regulator 10 was adjusted to provide 750 psig as indicated on gage 13.

## 4.2.3

Solenoid valves 17 and 18 were energized and then de-energized to cycle the valve from the closed to the opened to the closed position 10 times. Operation of the specimen was satisfactory. This procedure was performed during the initial functional test only.

## 4.2.4

VALVE LEAKAGE AND RESPONSE (GN<sub>2</sub>)

## 4.2.4.1

Valve Seat Leakage. Hand valves 20 and 21 were closed and all other hand valves were opened. Regulator 10 was adjusted to provide GN<sub>2</sub> at 750 psig to the actuator to hold the valve in the closed position. Regulator 5 was adjusted to provide GN<sub>2</sub> at 300 psig to the inlet side of the valve for 5 minutes. During this period, valve seat leakage was checked with flow-meter 9.

## 4.2.4.2

Valve Response. Timer 22 was installed in the indicating switch circuit as shown in figure 4-1A and the outlet of the test specimen was capped. Regulator 10 was adjusted to provide 750 psig to the actuator, and regulator 5 was adjusted to provide GN<sub>2</sub> at 300 psig to the test specimen inlet. The test specimen was opened and closed by energizing and de-energizing solenoid valves 17 and 18, and the opening and closing response times were recorded.

## 4.2.4.3

External Leakage. The outlet of the test specimen was capped. Regulator 10 was adjusted to provide 750 psig to the actuator, and solenoid valves 17 and 18 were energized to place the test specimen in the opened position. Regulator 5 was adjusted to provide 300 psig to the test specimen inlet. These pressures were maintained for 30 minutes and a check was made for external leakage by applying a leakage detection solution to the test specimen.

#### 4.2.5 VALVE LEAKAGE AND RESPONSE (LN<sub>2</sub>)

4.2.5.1 Valve Seat Leakage. Regulator 10 was adjusted to provide 750 psig to the actuator to hold the test specimen in the closed position. Hand valve 6 was closed and all other hand valves were opened. LN<sub>2</sub> was allowed to flow through the specimen until the specimen temperature stabilized. Hand valves 20 and 21 were closed. Regulator 5 was adjusted to provide 300 psig as shown on gage 8 and hand valve 6 was opened to pressurize the valve inlet for 5 minutes. During this period valve seat leakage was checked using flowmeter 9.

4.2.5.2 Valve Response. Timer 22 was installed in the indicating switch circuit as shown in figure 4-1A. Hand valve 6 was closed and all other hand valves were opened. LN<sub>2</sub> was allowed to flow through the test specimen until the specimen temperature stabilized. Hand valves 20 and 21 were closed. Regulator 5 was adjusted to provide 300 psig as shown on gage 8. Hand valve 6 was opened to pressurize the test specimen and regulator 10 was adjusted to provide 750 psig to the actuator. The test specimen was opened and closed by energizing and de-energizing solenoid valves 17 and 18. Opening and closing response times were recorded.

4.2.5.3 External Leakage. The outlet of the test specimen was capped. Regulator 10 was adjusted to provide 750 psig as shown on gage 13. Solenoid valves 17 and 18 were energized to place the test specimen in the open position. Hand valve 6 was closed and all other hand valves were opened. LN<sub>2</sub> was allowed to flow through the test specimen until the temperature of the test specimen stabilized. Hand valves 20 and 21 were closed. Regulator 5 was adjusted to provide 300 psig to the test specimen inlet. External leakage was checked for 30 minutes by applying a leakage detection solution to the test specimen actuator.

4.2.5.4 Loss of Actuator Pressure Response. The outlet of the test specimen was capped. Regulator 10 was adjusted to provide 750 psig to the actuator, and solenoid valves 17 and 18 were energized to place the test specimen in the opened position. Hand valves 20 and 21 were opened and all other hand valves were closed. LN<sub>2</sub> was allowed to flow through the test specimen until the specimen temperature stabilized. Hand valves 20 and 21 were closed. Regulator 5 was adjusted to provide 300 psig as shown on gage 8 and hand valve 6 was opened to pressurize the test specimen. Solenoid valve 18 was de-energized, simulating a loss of actuator pressure. The closing response time was measured.

#### 4.2.6 Insulation Resistance

Insulation resistance was measured by applying 500 vdc for 60 seconds to the appropriate terminals of the indicating switches. Insulation resistance was measured between each terminal and the case, and between all nonconnected terminals.

4.3

TEST RESULTS

The results of the initial functional test were satisfactory. There was no leakage. Valve response and insulation resistance measurements were within specification limits.

4.4

TEST DATA

The data presented in table 4-2 were recorded during the initial functional test.

Table 4-1. Functional Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Hadley Valve Co.	11953-6	1 and 2	Butterfly valve, 6-inch, 300-psig
2	Hand Valve*	Hoke	NA	NA	1/4-inch
3	Pressure Gage*	Ashcroft	NA	NA	0-to 5500-psig Cal. date 9/6/66
4	Filter	Bendix	1731260	570015	10-micron nominal 5-micron absolute
5	Pressure Regulator*	Marotta	NA	NA	
6	Hand Valve*	Hoke	NA	NA	1/4-inch
7	Hand Valve*	Hoke	NA	NA	1/4-inch
8	Pressure Gage*	Heise	NA	NA	0-to 3500-psig Cal. date 9/6/66
9	Flowmeter	Fisher Porter	NA	200595 E thru H	
10	Pressure Regulator*	Tescom	NA	NA	
11	Hand Valve*	Hoke	NA	NA	1/4-inch
12	Hand Valve*	Hoke	NA	NA	1/4-inch
13	Pressure Gage*	Heise	NA	NA	0-to 3500-psig Cal. date 9/6/66
14	Switch*	Minneapolis-Honeywell	NA	NA	SPST
15	Switch*	Minneapolis-Honeywell	NA	NA	SPST
16	Indicator Panel	CCSD	NA	NA	

\* This part is a component of cryogenic test console 200586 (NASA special equipment).

Table 4-1. Functional Test Equipment List (Continued)

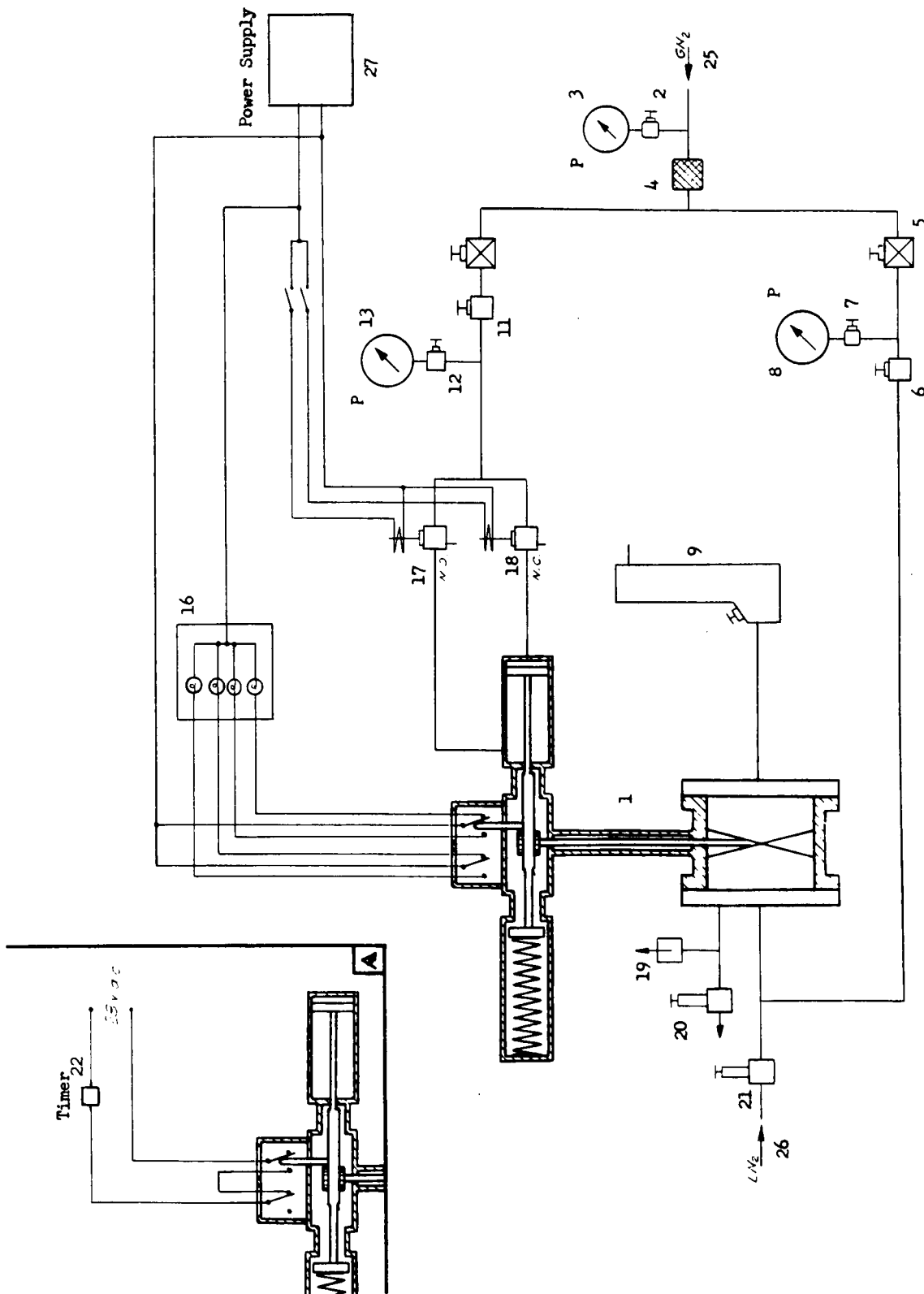
Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
17	Solenoid Valve	Marotta	MV-74	819	2-position, 3-way
18	Solenoid Valve	Marotta	MV-74	824	2-position, 3-way
19	Relief Valve	Anderson Greenwood	NA	23645	1/2-inch cryogenic
20	Hand Valve	Flowmatics Inc.	NA	2581	1/2-inch cryogenic
21	Hand Valve	Hydromatics	NA	6121B	1/2-inch cryogenic
22	Timer*	Standard Electric Time Co.	NA	NA	
23	Megohmmeter**	General Radio Co.	NA	4533	500-vdc
24	Power Supply		NA	NA	28-vdc
25	GN <sub>2</sub> Source				
26	LN <sub>2</sub> Source				

\* This part is a component of cryogenic test console 200586 (NASA special equipment).

\*\* Not shown in schematic.

Table 4-2. Initial Functional Test Data

Test Medium	Item Determined	Specimen	
		1	2
$\text{GN}_2$ ↓ $\text{LN}_2$ ↓	Valve Operation	Satisfactory	Satisfactory
	Valve Seat Leakage (sccm)	0	0
	Valve Response Time (ms) Open	88	94
	Close	279	271
	External Leakage	None	None
	Valve Seat & Leakage (sccm)	0	0
	Valve Response Time (ms) Open	84	148
	Close	300	265
	External Leakage	None	None
	Loss of Actuator Pressure Response Time (ms)	498	1175
	Insulation Resistance (megohm)	40,000 min.	30,000 min.



Note: All lines  $\frac{1}{4}$  inch.  
Refer to table 4-1 for item identification.  
Figure 4-1. Functional Test Schematic

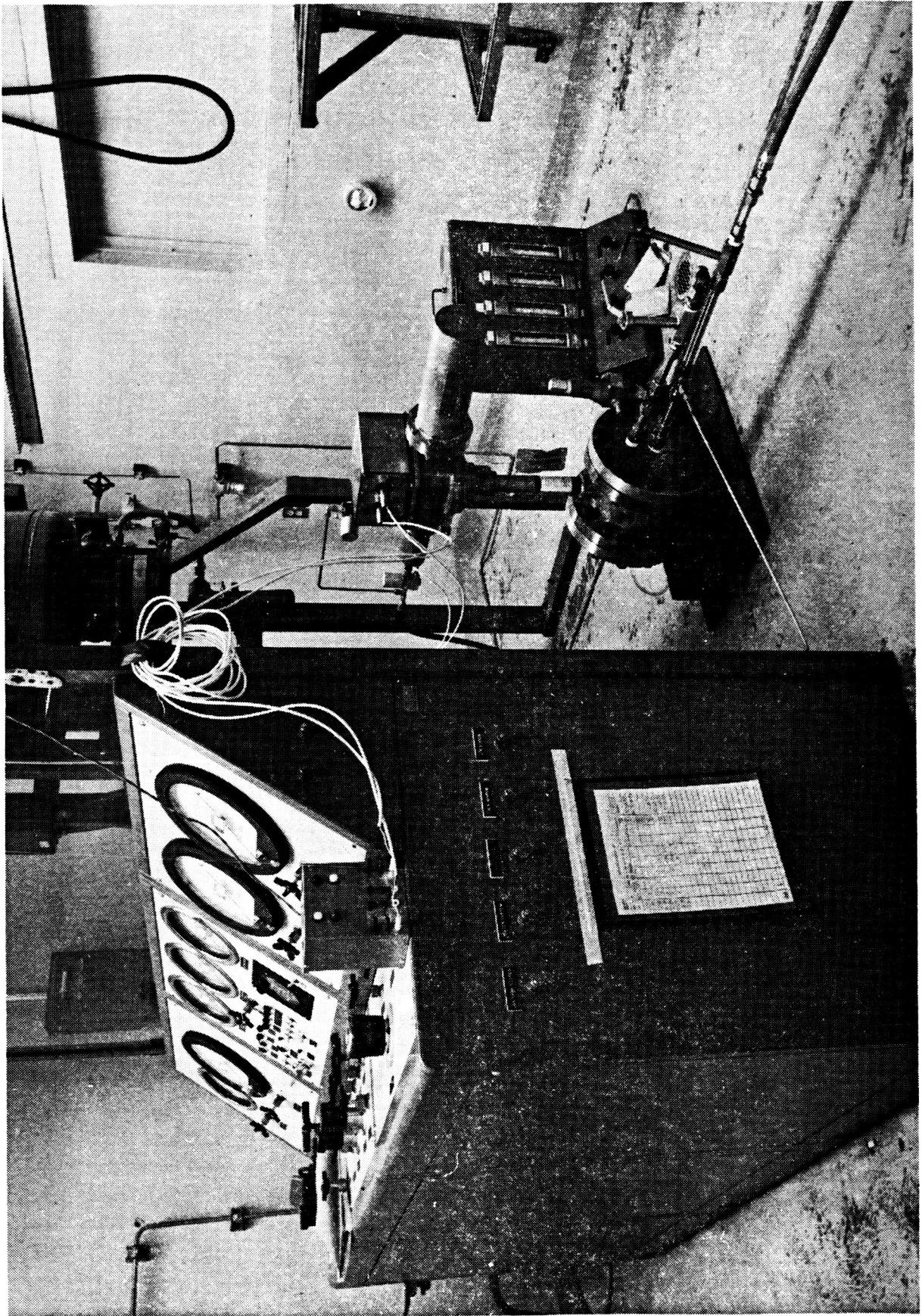


Figure 4-2. Functional Test Setup

SECTION V  
TEMPERATURE SHOCK TEST

5.1        TEST REQUIREMENTS

- 5.1.1        A temperature shock test will be performed on one test specimen to determine whether the sudden temperature changes cause degradation or deformation.
- 5.1.2        The rated high temperature is 125 (+4, -0)°F.
- 5.1.3        When temperature stabilization occurs, a functional test shall be performed using GN<sub>2</sub> at 60 (+30, -0)°F.
- 5.1.4        A functional test shall be performed at rated high temperature by allowing LN<sub>2</sub> to flow through the test specimen within 2 minutes for a flow period of 1 minute.

5.2        TEST PROCEDURE

- 5.2.1        The test specimen was placed in a high temperature chamber as shown in figures 5-1 and 5-2 using the equipment listed in table 5-1.
- 5.2.2        Conditions within the enclosure were maintained at 125°F and 20 (+5) per cent relative humidity.
- 5.2.3        When the specimen temperature was stabilized, a functional test was performed as specified in paragraphs 4.2.4.1 and 4.2.4.2.
- 5.2.4        LN<sub>2</sub> was allowed to flow through the test specimen within 2 minutes.
- 5.2.5        A functional test was performed as specified in paragraphs 4.2.5.1, 4.2.5.2, and 4.2.5.4.
- 5.2.6        The high temperature chamber was returned to room ambient conditions and the test specimen was subjected to a functional test as specified in paragraphs 4.2.5.1 through 4.2.5.4.

5.3        TEST RESULTS

The results of the temperature shock test and the subsequent functional test were satisfactory.

5.4        TEST DATA

The data presented in table 5-2 were recorded during and after the temperature shock test.

Table 5-1. Temperature Shock Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Hadley Valve Co.	11953-6	2	Butterfly valve, 6-inch, 300-psig
2	Hand Valve*	Hoke	NA	NA	1/4-inch
3	Pressure Gage*	Ashcroft	NA	NA	0-to 5500-psig Cal. date 9/6/66
4	Filter	Bendix	1731260	570015	10-micron nominal 5-micron absolute
5	Pressure Regulator*	Marotta	NA	NA	
6	Hand Valve*	Hoke	NA	NA	1/4-inch
7	Hand Valve*	Hoke	NA	NA	1/4-inch
8	Pressure Gage*	Heise	NA	NA	0-to 1000-psig Cal. date 9/6/66
9	Temperature Read-out	West Instrument Co.	NA	019461	Cal. date 10/3/66
10	Flowmeter	Fisher Porter	NA	200595 E thru H	
11	Pressure Regulator*	Tescom	NA	NA	
12	Hand Valve*	Hoke	NA	NA	1/4-inch
13	Hand Valve*	Hoke	NA	NA	1/4-inch
14	Pressure Gage*	Heise	NA	NA	0-to 3500-psig Cal. date 9/6/66
15	Switch*	Minneapolis-Honeywell	NA	NA	SPST

\* This part is a component of cryogenic test console 200586 (NASA special equipment).

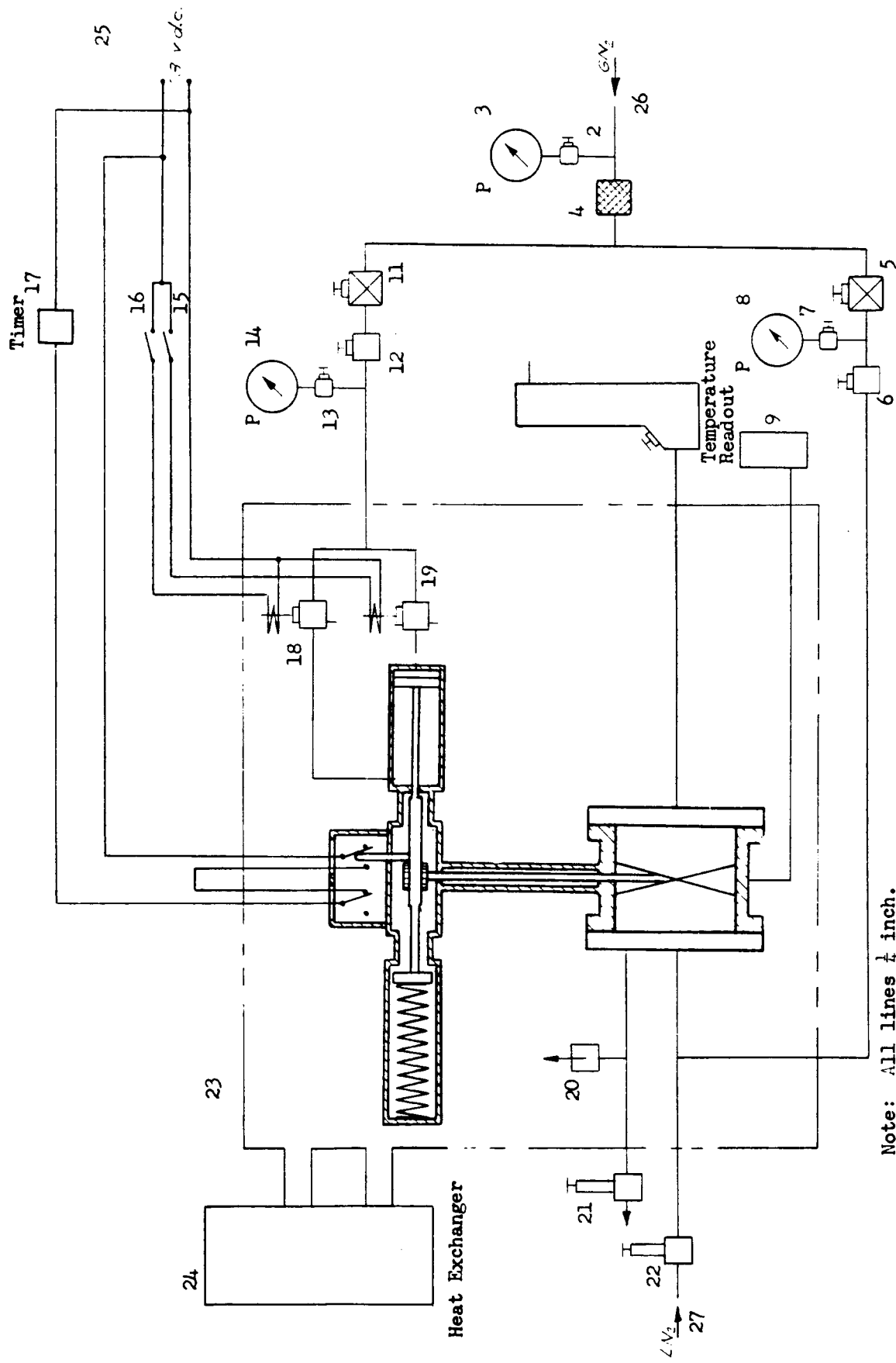
Table 5-1. Temperature Shock Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
16	Switch*	Minneapolis-Honeywell	NA	NA	SPST
17	Timer	CCSD	NA	NA	
18	Solenoid Valve	Marotta	MV-74	17747	2-position, 3-way
19	Solenoid Valve	Marotta	MV-74	17745	2-position, 3-way
20	Relief Valve	Anderson Greenwood	NA	23645	1/2-inch cryogenic
21	Hand Valve	Flowmatics, Inc.	NA	2581	1/2-inch cryogenic
22	Hand Valve	Hydromatics	NA	6121B	1/2-inch cryogenic
23	Temperature Chamber	CCSD	NA	NA	
24	Heat Exchanger	Thermotron Corp.	NA	200895-13	
25	Power Supply		NA	NA	28-vdc
26	GN <sub>2</sub> Source		NA	NA	
27	LN <sub>2</sub> Source		NA	NA	

\* This part is a component of cryogenic test console 200586 (NASA special equipment).

Table 5-2. Functional Test Data Pertaining to  
Temperature Shock Test

Environmental Conditions		125°F	Temperature Shock	Room Temperature
Test Medium		GN <sub>2</sub>	GN <sub>2</sub>	LN <sub>2</sub>
Valve Seat Leakage (sccm)		0	0	0
Valve Response Time (ms)	Open	325	350	127
	Close	285	310	268
External Leakage		--	--	0
Loss of Actuator Pressure-Response (ms)		--	1620	1168



Note: All lines  $\frac{1}{4}$  inch.  
Refer to table 5-1 for item identification.  
Figure 5-1. Temperature Shock Test Schematic

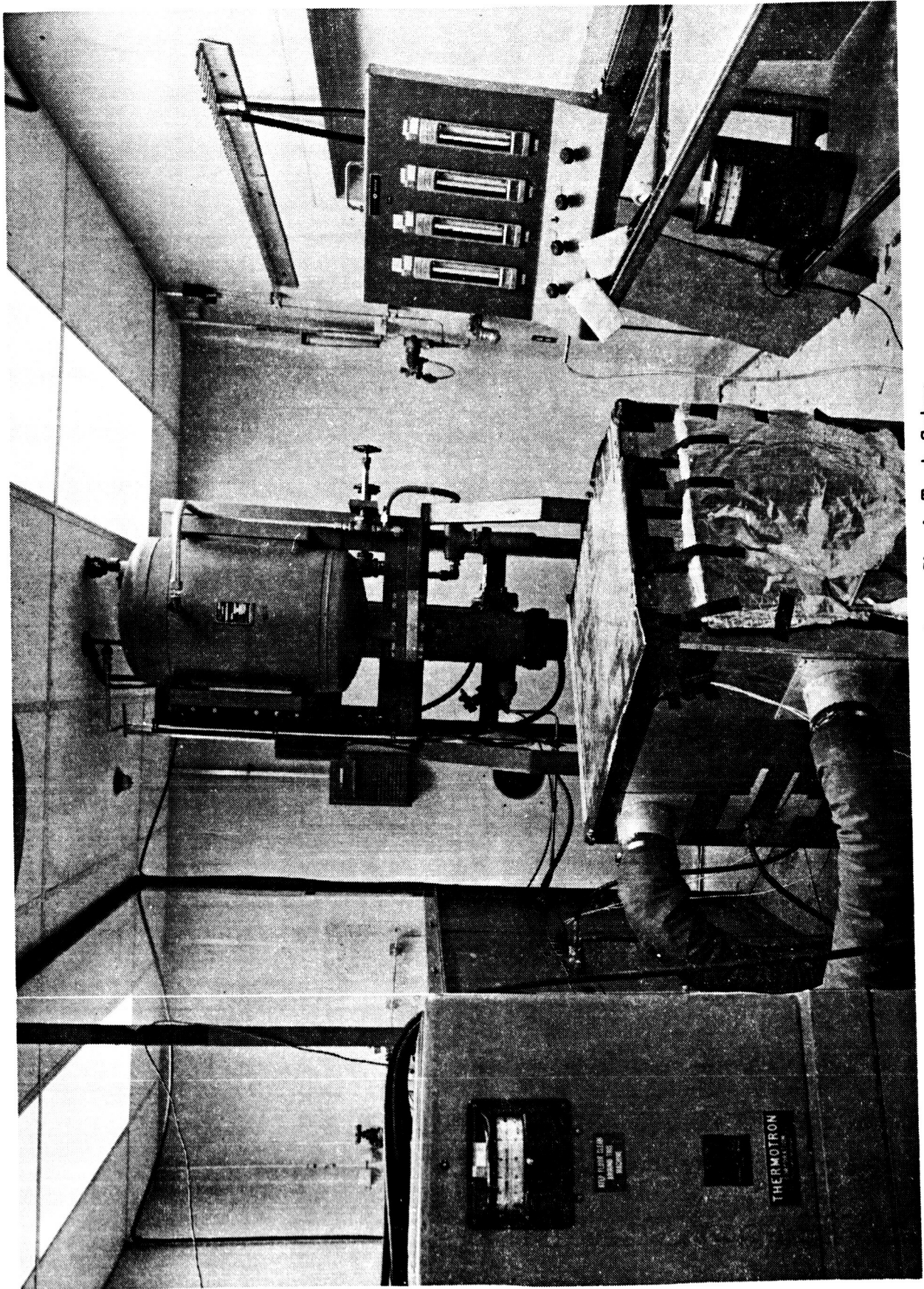


Figure 5-2. Temperature Shock Test Setup

SECTION VI  
VIBRATION TEST

6.1        TEST REQUIREMENTS

- 6.1.1      The vibration test shall be performed in accordance with section 9 of KSC-STD-164(D), procedure I, figures 9.1 and 9.2, level E.
- 6.1.2      The test specimen shall be subjected to sinusoidal and random vibration along three mutually perpendicular axes.
- 6.1.3      Upon completion of sinusoidal and random vibration along each axis, the test specimen shall be subjected to a functional test.

6.2        TEST PROCEDURE

- 6.2.1      The test specimen was installed on a vibration exciter as shown in figure 6-1 using the equipment listed in table 6-1 to permit application of vibration along the X-axis.

6.2.2      RESONANT FREQUENCY SEARCH

The test specimen was subjected to sinusoidal vibration by scanning the frequency range logarithmically from 5 to 3000 cps and from 3000 to 5 cps for a test period not exceeding 15 minutes. Actual test time and all resonant frequencies of the test specimen were recorded. Vibration levels were as follows:

5 to 45 cps at 0.01-inch DA displacement

45 to 3000 cps at 1.0g peak

6.2.3      SINUSOIDAL SWEEP

- 6.2.3.1    The test specimen was subjected to sinusoidal vibration by scanning the frequency range logarithmically from 10 to 2000 cps and from 2000 to 10 cps for 20 minutes (10 minutes up and 10 minutes back). All critical frequencies were noted. Vibration levels were as follows:

10 to 45 cps at 0.05-inch DA displacement

45 to 2000 cps at 5g peak

- 6.2.3.2    Upon completion of the sinusoidal scan, a functional test was performed as specified in paragraphs 4.1.3.1 and 4.1.3.2.

6.2.4      RANDOM VIBRATION

6.2.4.1

The test specimen was subjected to random vibration over the frequency range of 10 to 2000 cps for 5 minutes. Vibration levels were as follows:

10 to 100 cps at +6 db/octave

100 to 1000 cps at 0.005 g<sup>2</sup>/cps

1000 to 2000 cps at -6 db/octave

6.2.4.2

Upon completion of random vibration, a functional test was performed as specified in paragraphs 4.1.3.1 and 4.1.3.2.

6.2.5

The test specimen was subjected to vibration along the remaining two mutually perpendicular axes in accordance with paragraphs 6.2.2 through 6.2.4.2, (See figures 6-2 and 6-3.)

6.2.6

Upon completion of the vibration test, a functional test was performed as specified in paragraphs 4.1.4.1, 4.1.4.2, and 4.1.4.4.

6.3

#### TEST RESULTS

The results of the vibration test and the follow-up functional tests were satisfactory. No critical frequencies were noted.

6.4

#### TEST DATA

Post-vibration functional test data are presented in table 6-2.

Resonant frequencies noted during the resonant frequency search are presented in table 6-3.

Sinusoidal sweep, random, and resonant search plots are presented in figures 6-4 through 6-18.

Table 6-1. Vibration Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Hadley Valve Co.	11953-6	2	Butterfly valve, 6-inch, 300-psig
2	Vibration Exciter	MB Electronics	210	NA	
3	Test Fixture	CCSD	NA	NA	

Table 6-2. Functional Test Data (Post Vibration)

Vibration Axis	X		Y		Z	
Vibration Waveform	Sine	Random	Sine	Random	Sine	Random
Test Medium	GN <sub>2</sub>	GN <sub>2</sub>	GN <sub>2</sub>	GN <sub>2</sub>	GN <sub>2</sub>	LN <sub>2</sub>
Valve Seat Leakage (sccm)	0	0	0	0	0	0
Valve Response Time (ms)	360	312	303	295	295	295
	282	300	290	283	289	291
Loss of Actuator Pressure Response (ms)	1273	1175	1030	1030	1000	1000

Table 6-3. Specimen Resonant Frequencies

Axis	Resonant Frequencies (cps)							
X	56	115	175	220				
Y	58	115	180	760	960	1150	1400	
Z	57	115	180					

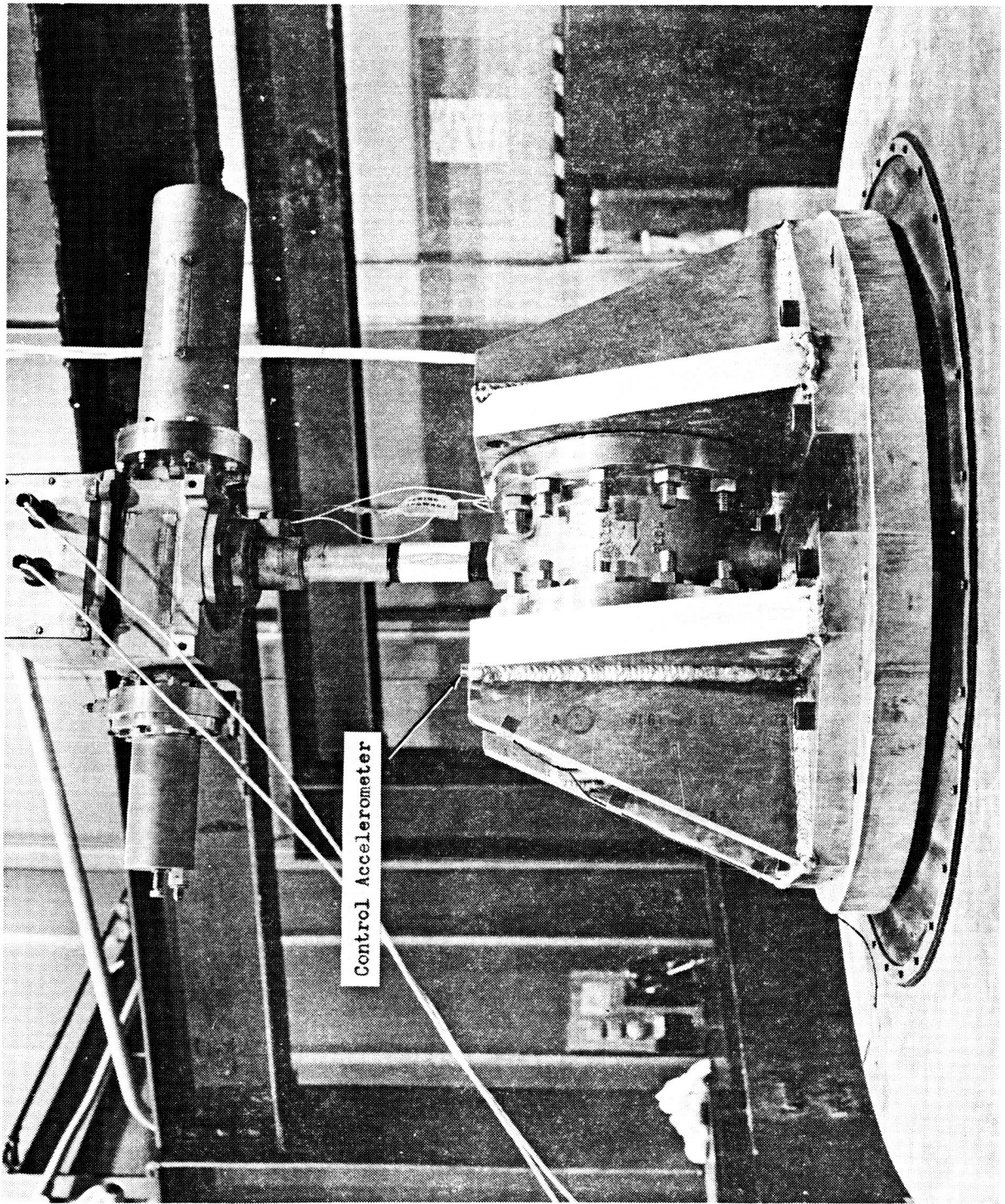


Figure 6-1. Vibration Test Setup, X-Axis

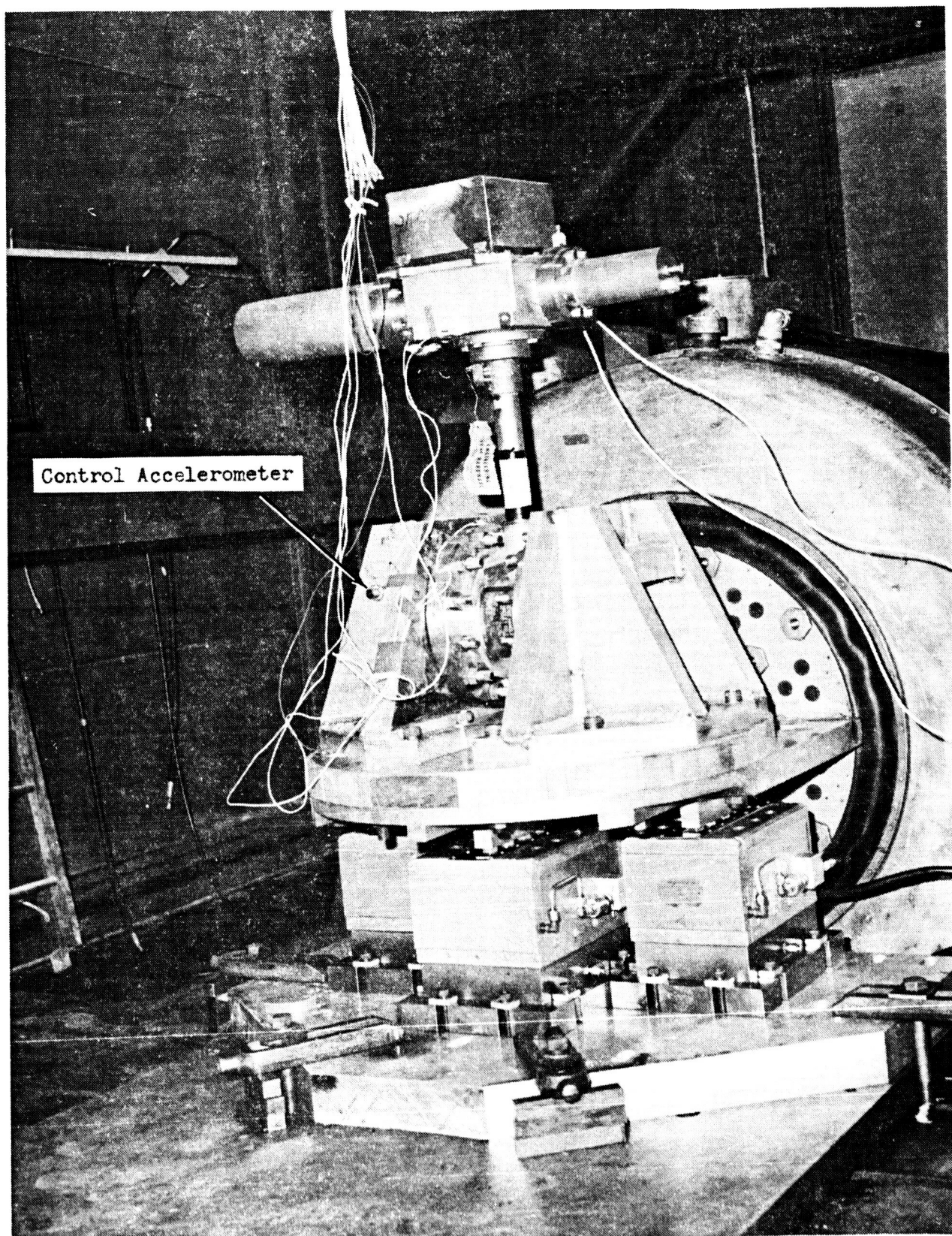


Figure 6-2. Vibration Test Setup, Y-Axis

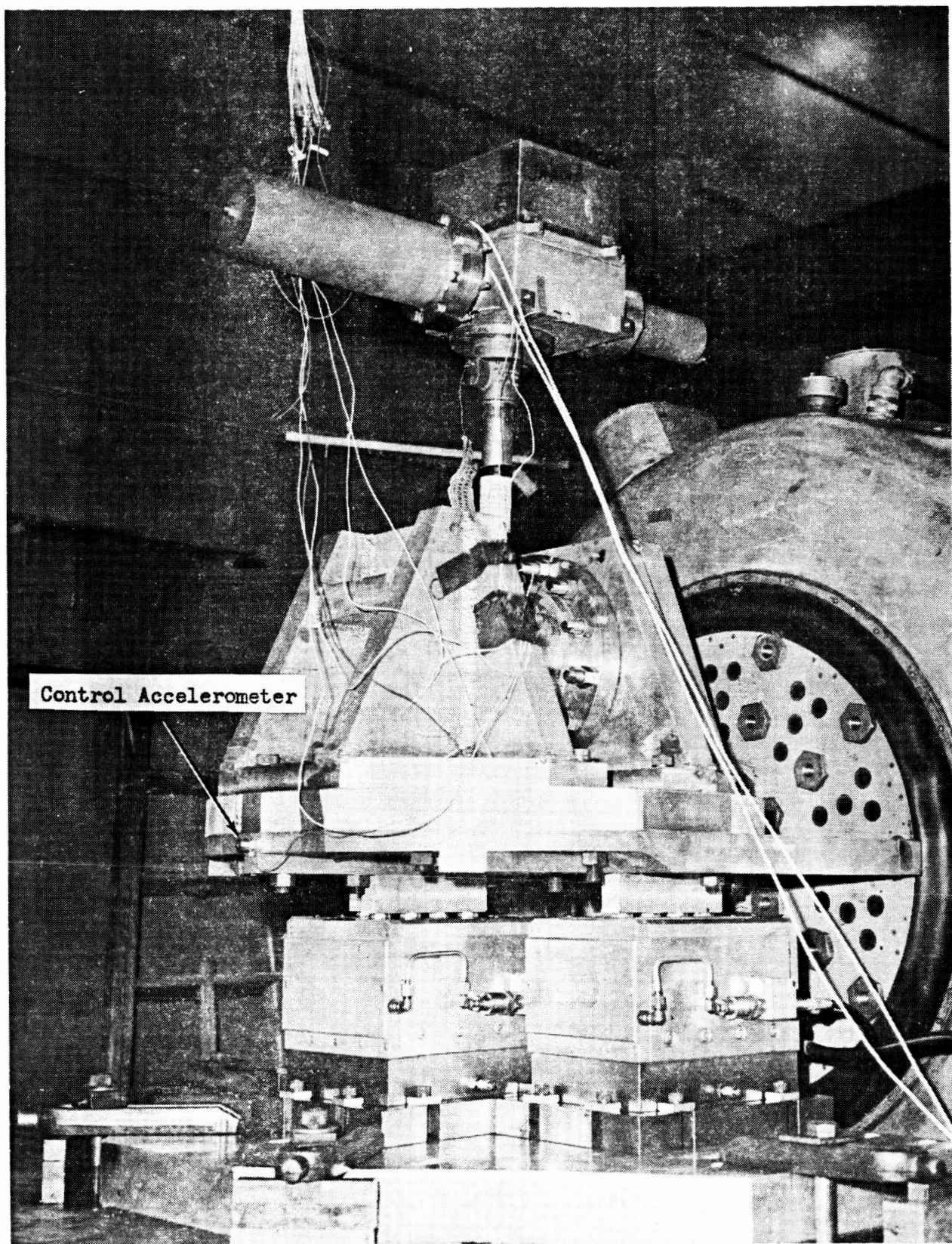


Figure 6-3. Vibration Test Setup, Z-Axis

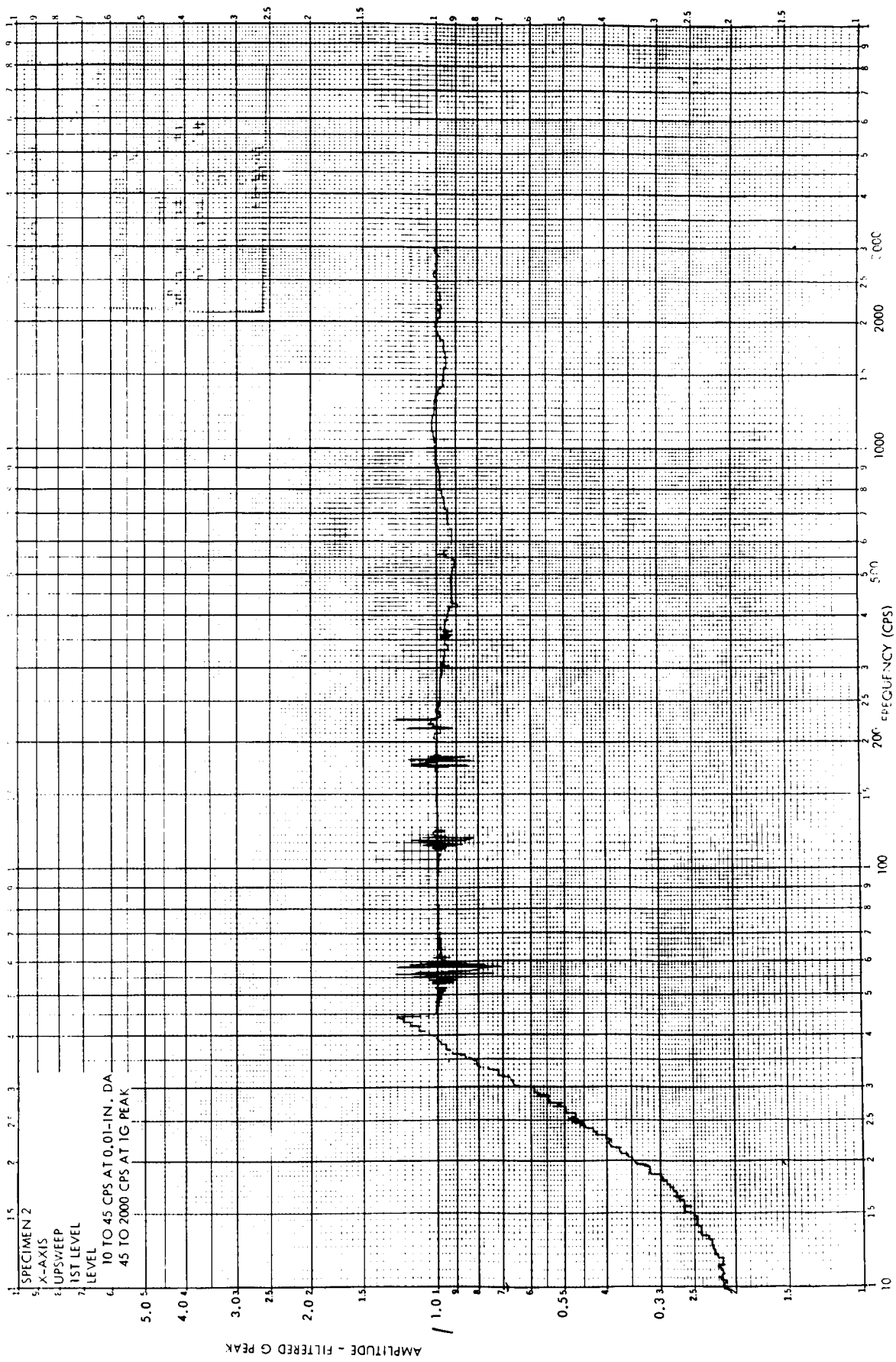


Figure 6-4. Resonant Frequency Upsweep Recording,  
Specimen 2, X-axis

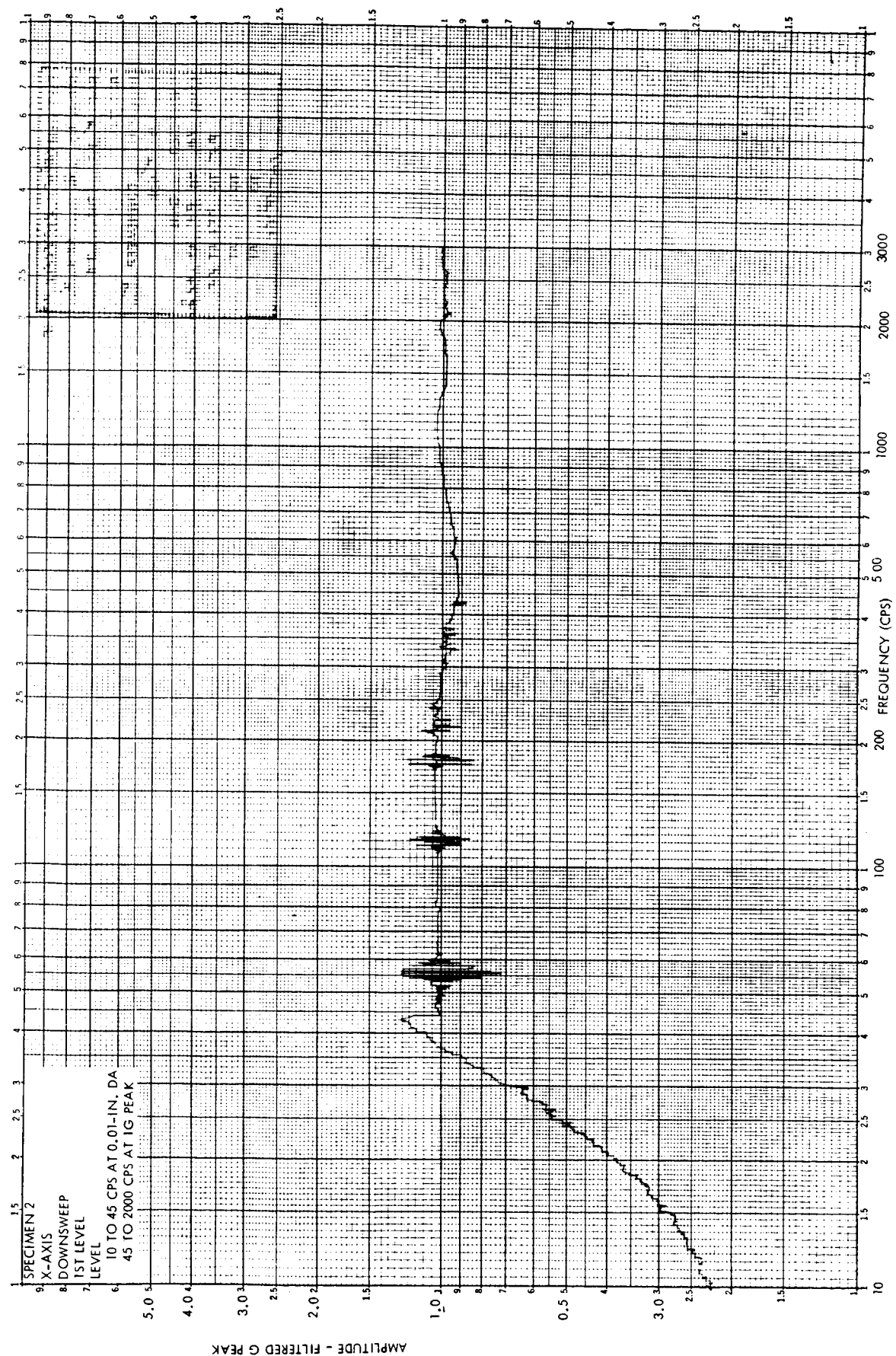


Figure 6-5. Resonant Frequency Downsweep Recording, Specimen 2, X-Axis

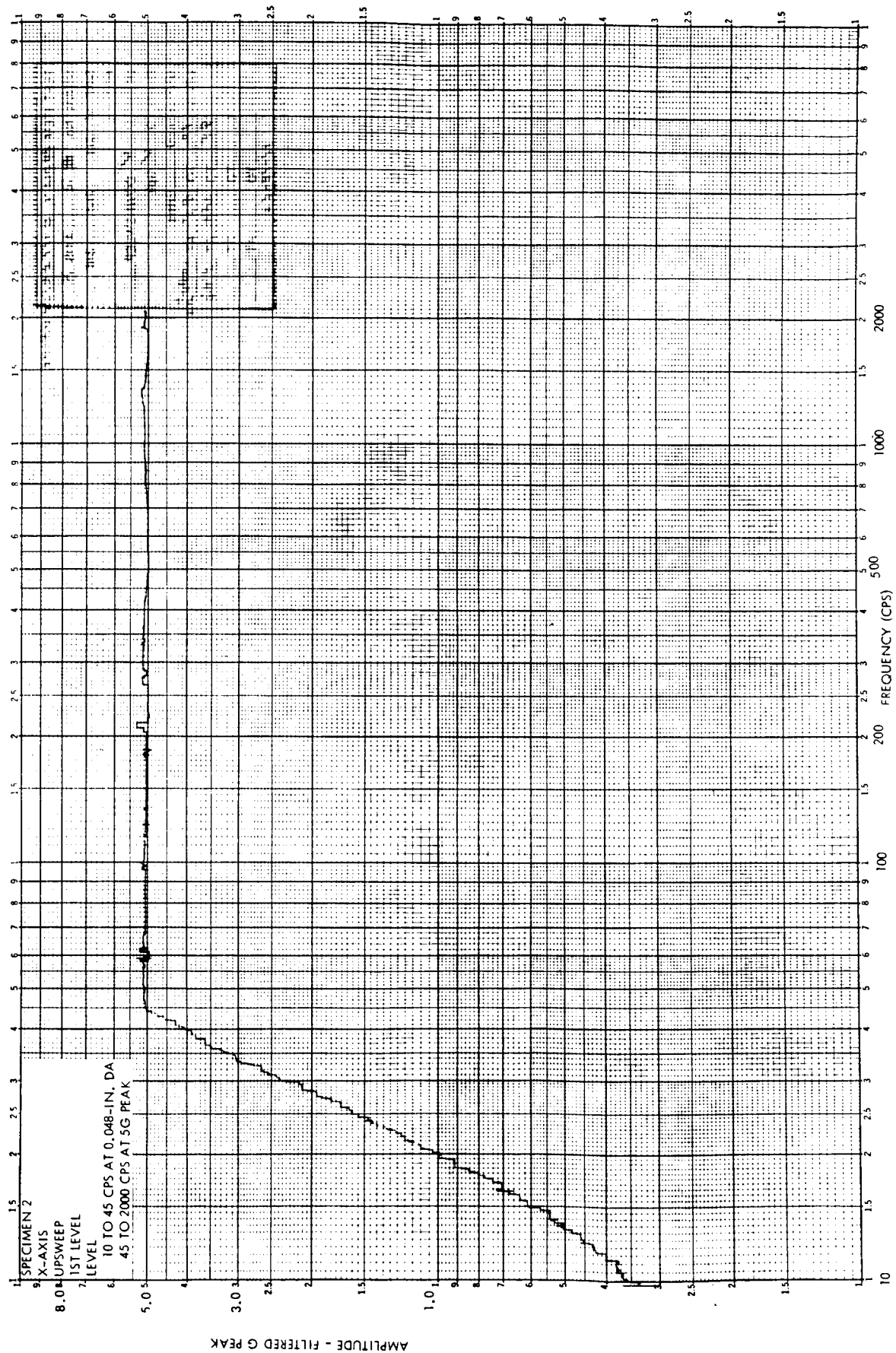


Figure 6-6. Sinusoidal Upsweep Recording, Specimen 2, X-Axis

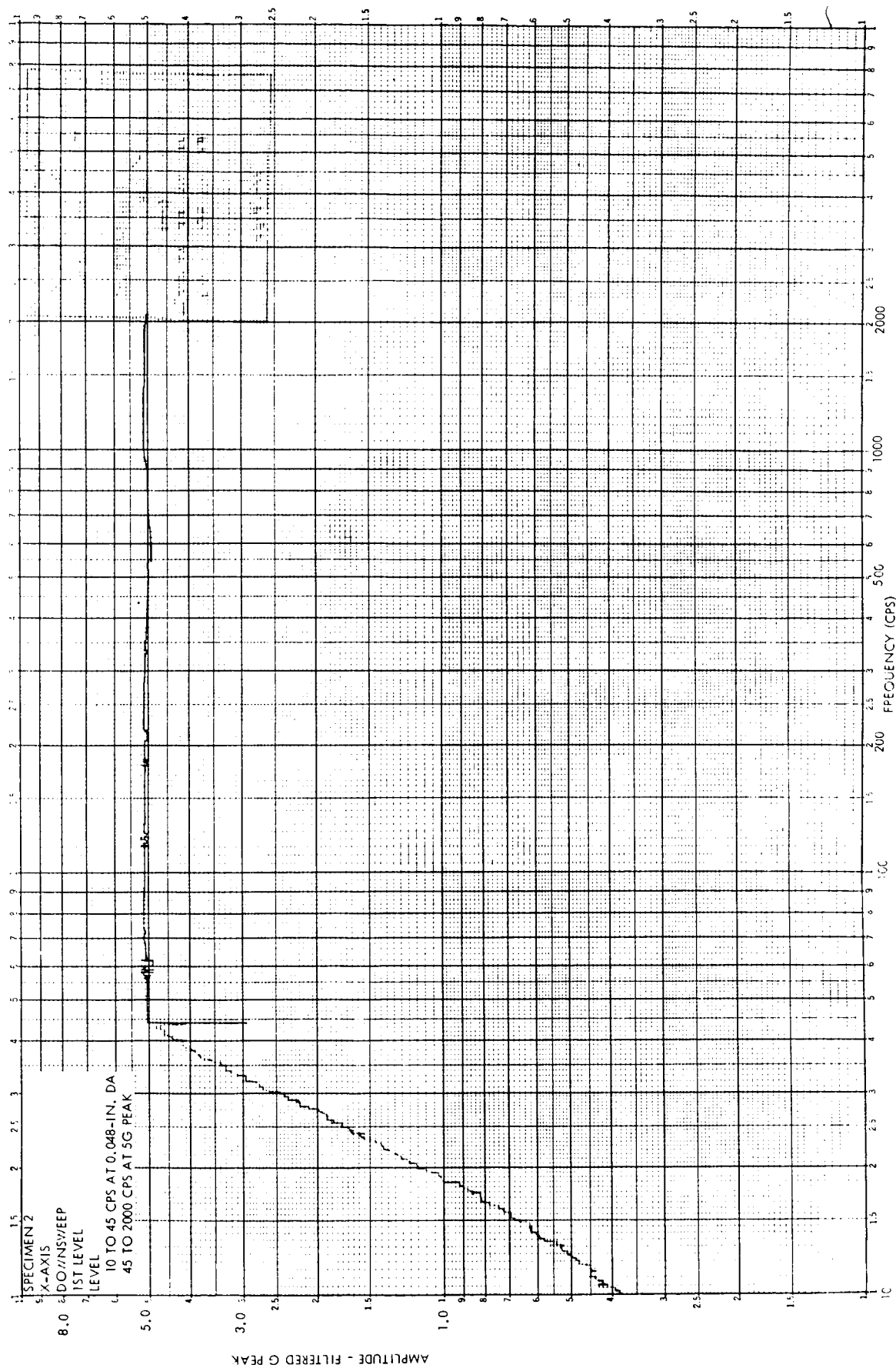


Figure 6-7. Sinusoidal Downsweep Recording, Specimen 2, X-axis

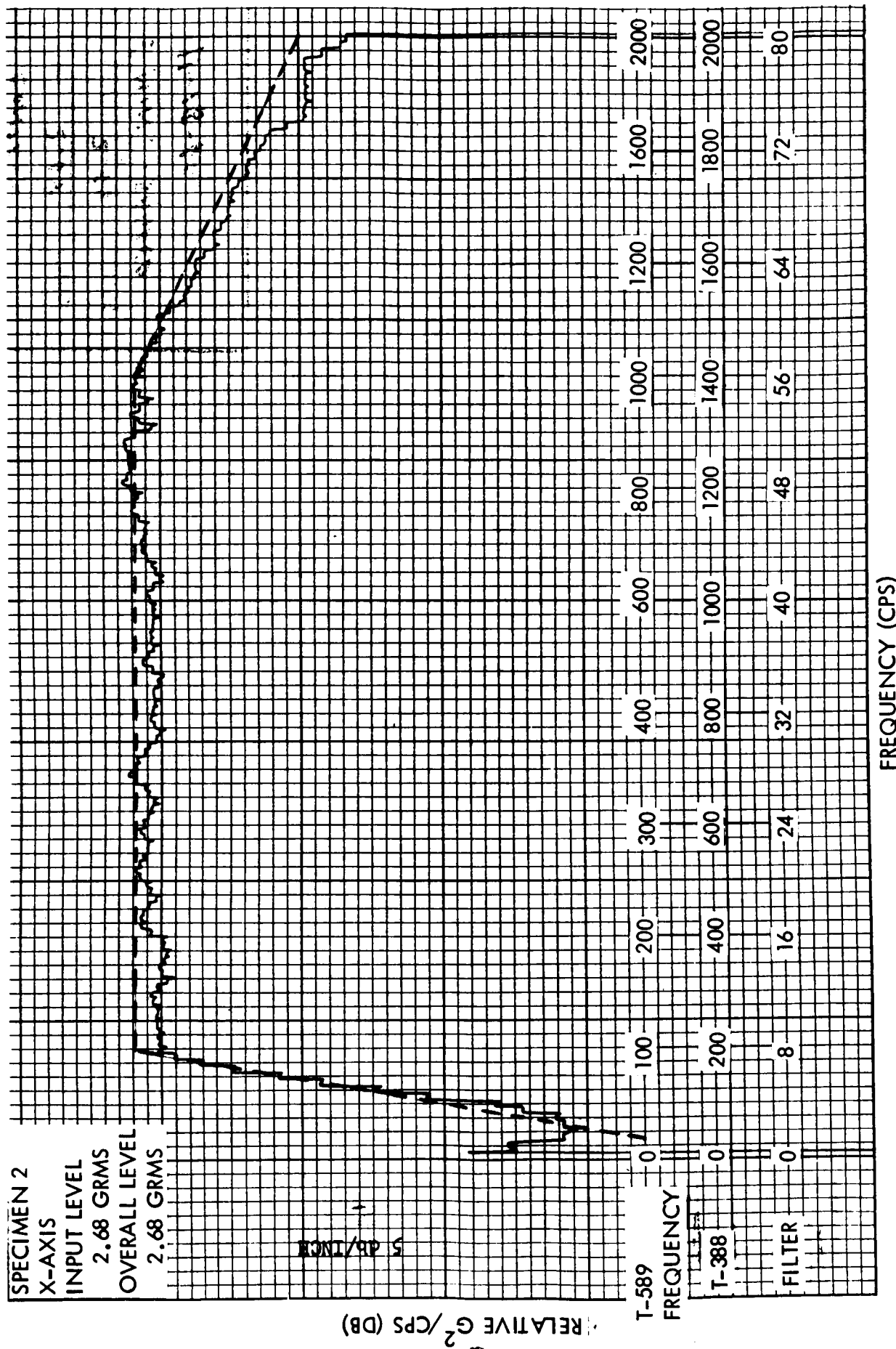


Figure 6-8. Random Vibration Recording,  
Specimen 2, X-Axis

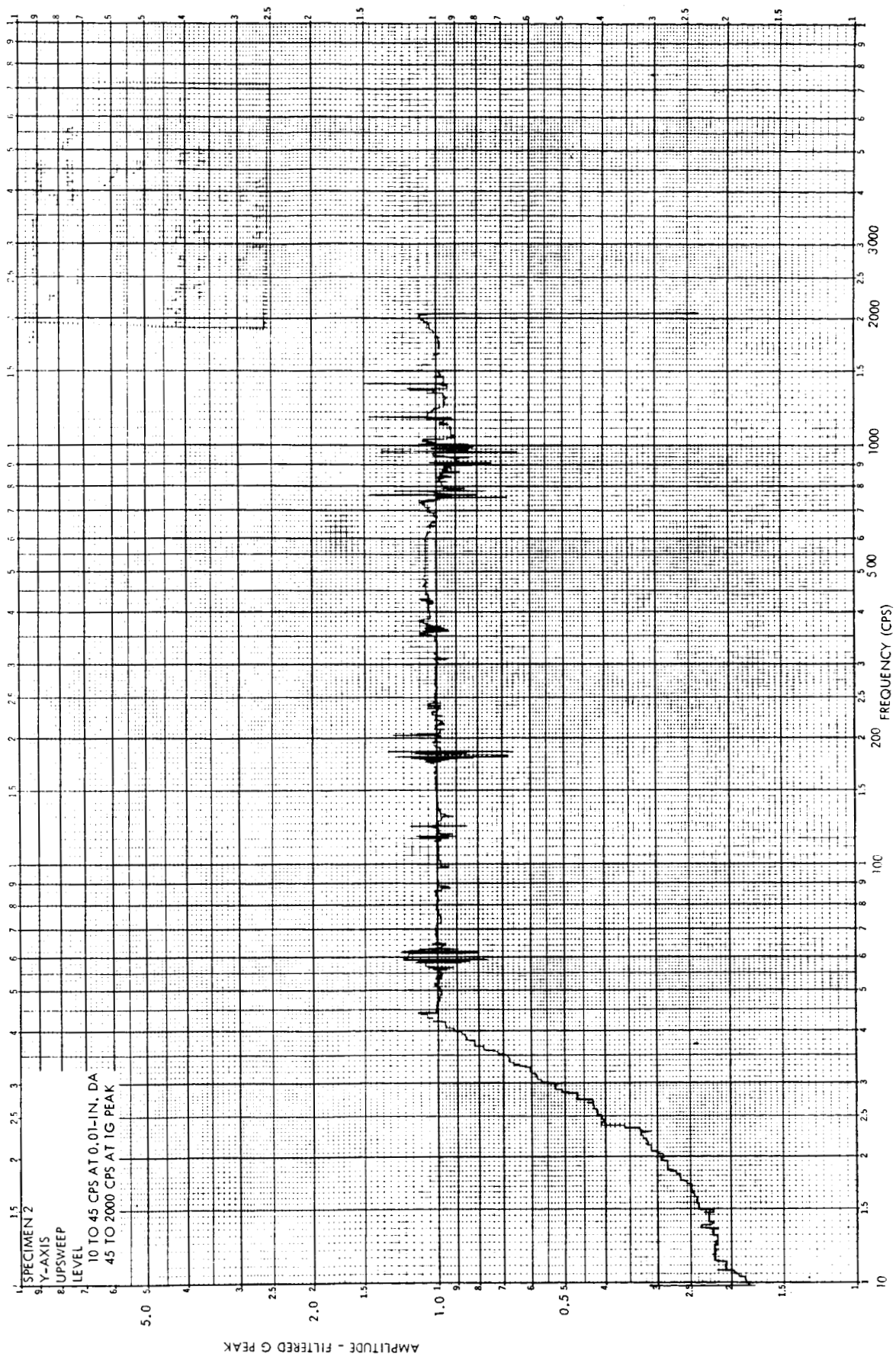


Figure 6-9. Resonant Frequency Upsweep Recording, Specimen 2, Y-Axis

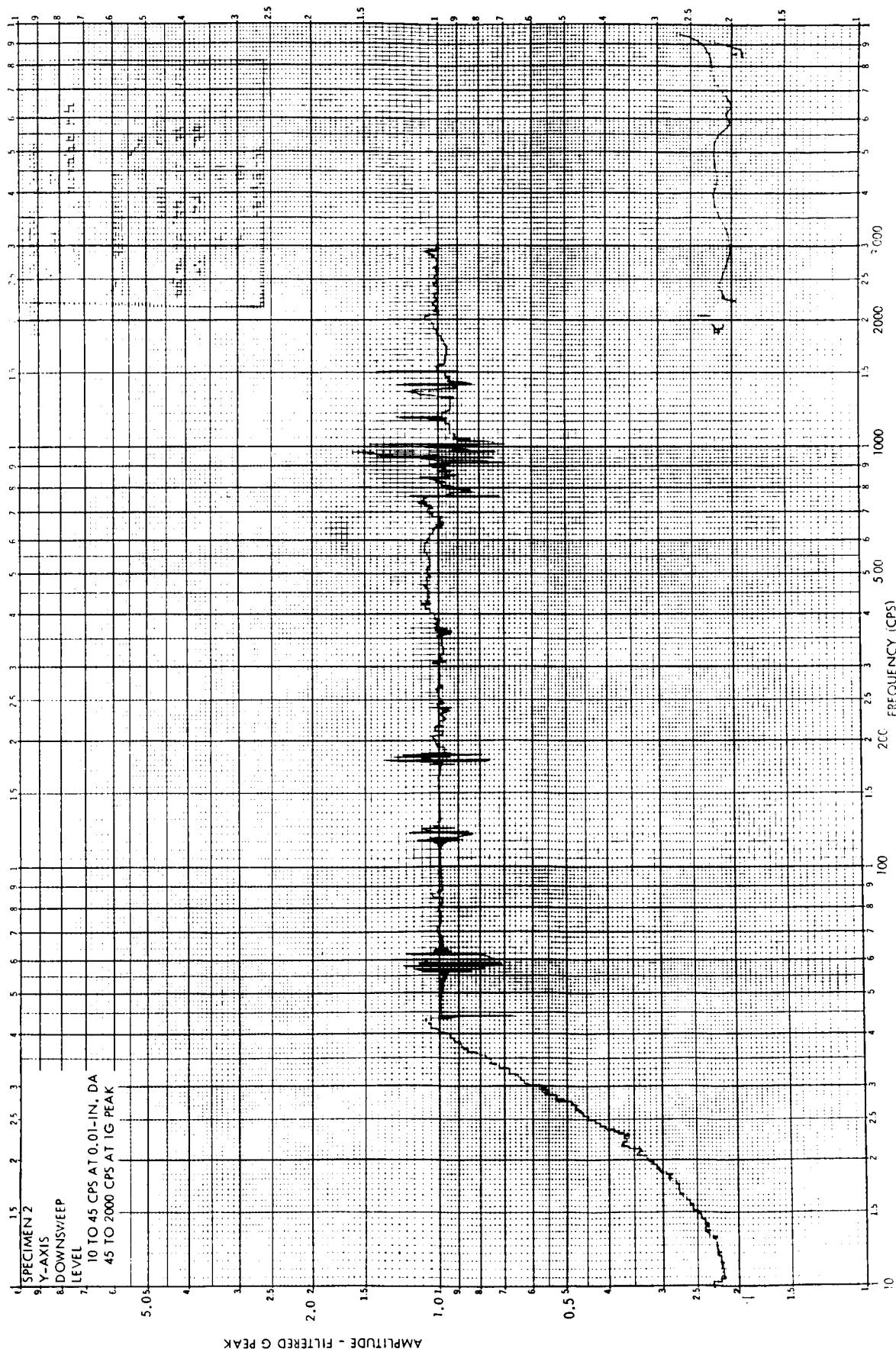


Figure 6-10. Resonant Frequency Downsweep Recording, Specimen 2, Y-axis

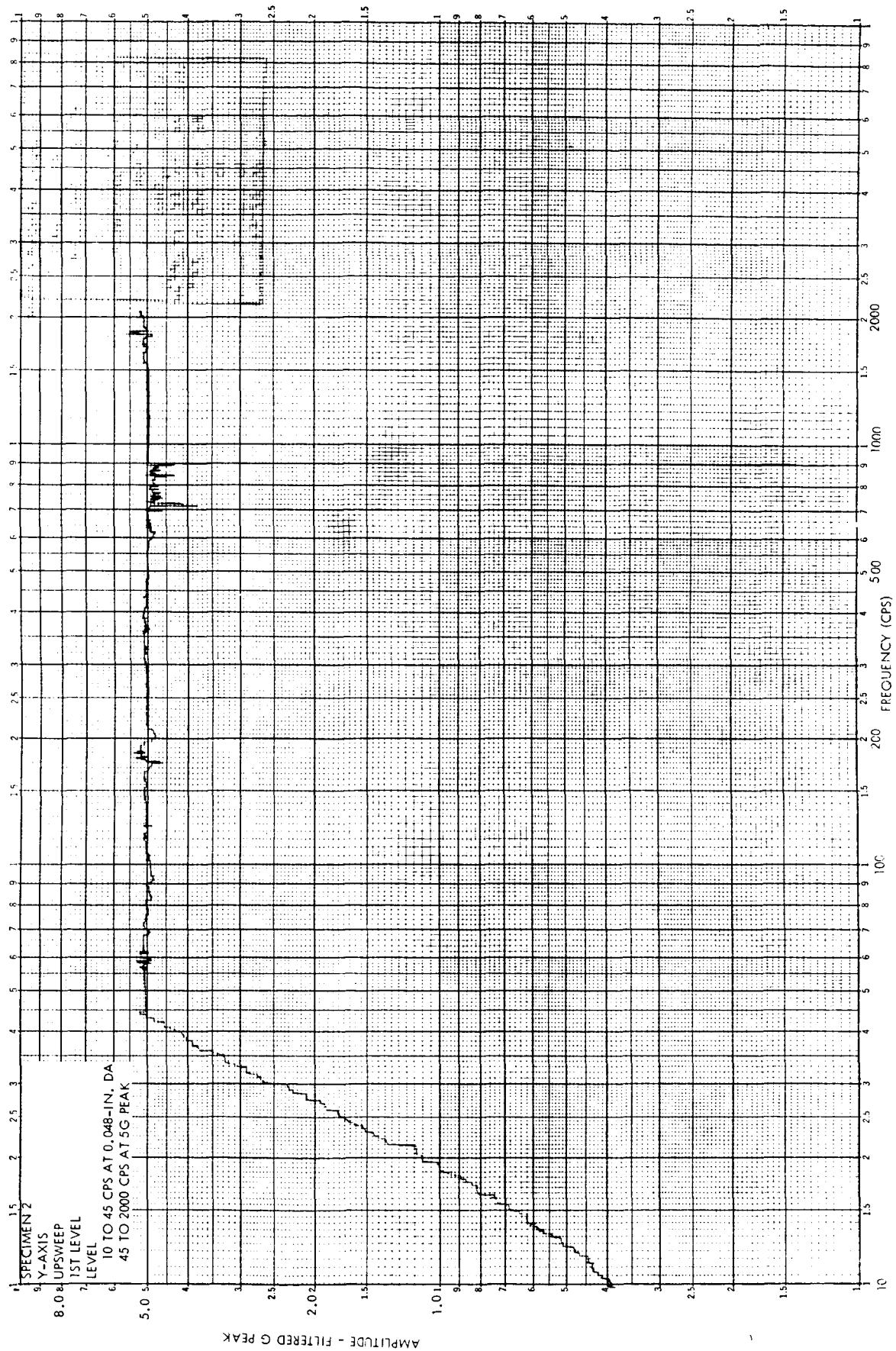


Figure 6-11. Sinusoidal Upsweep Recording, Specimen 2, Y-Axis



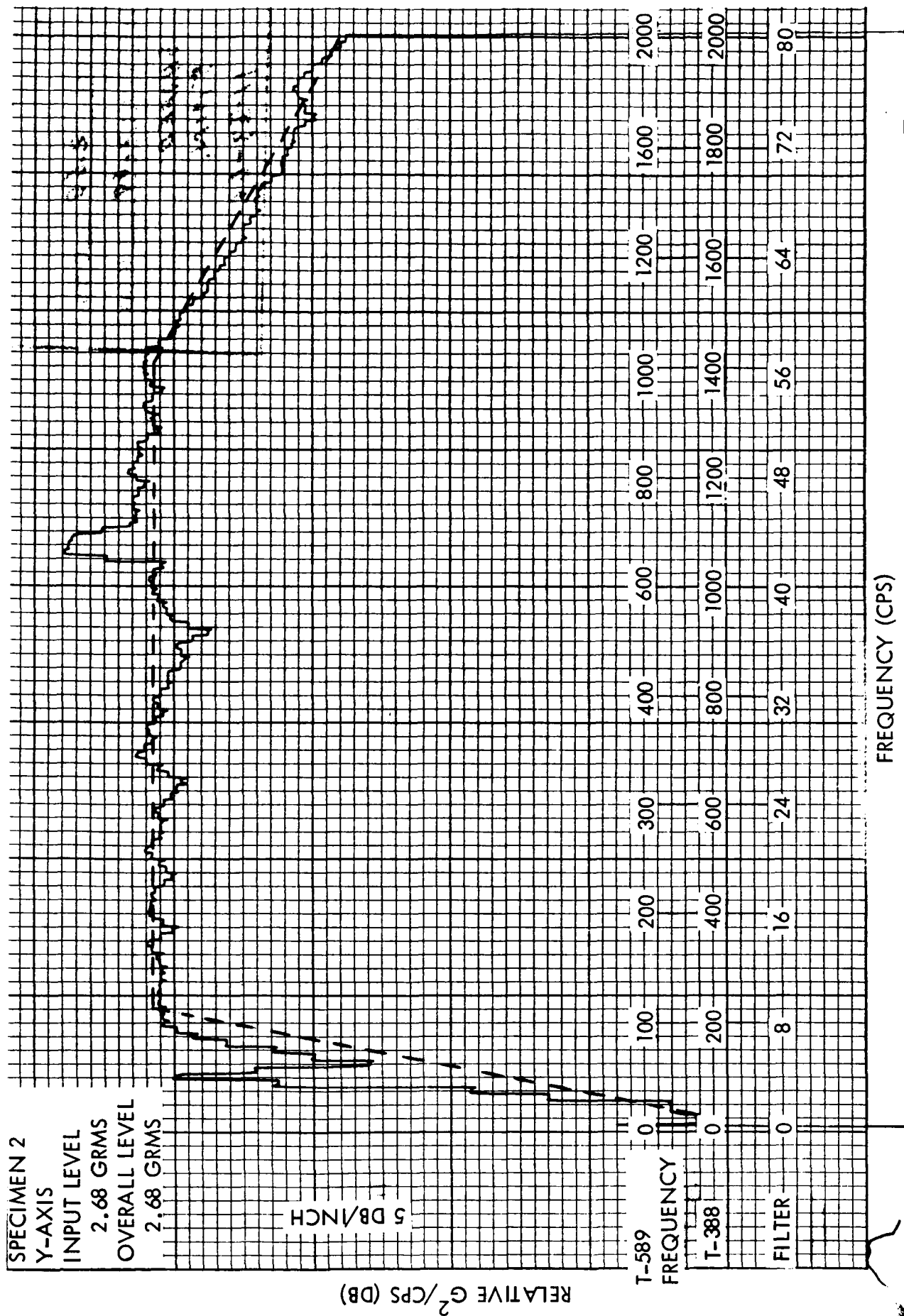


Figure 6-13. Random Vibration Recording,  
Specimen 2, Y-Axis

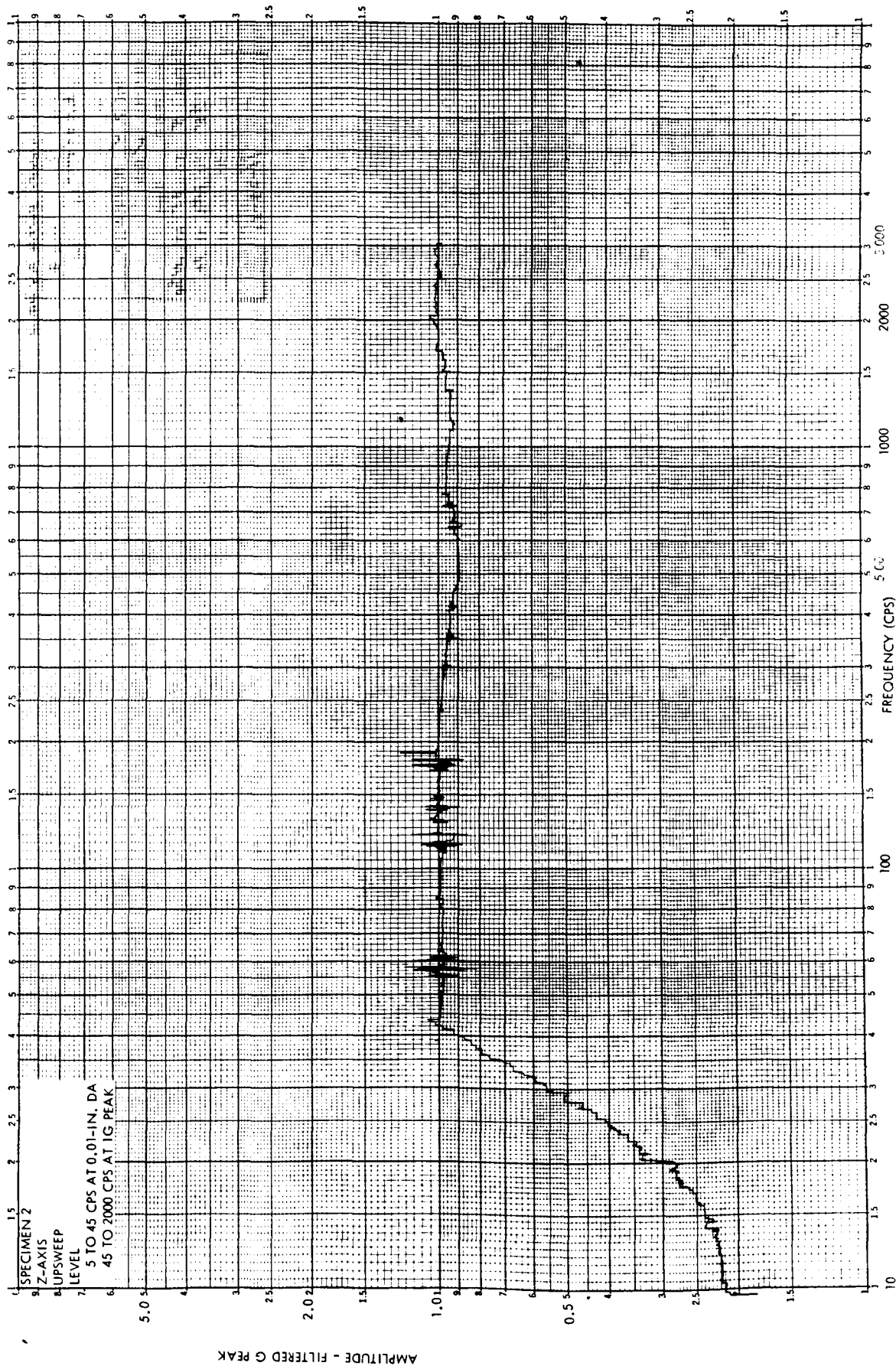


Figure 6-14. Resonant Frequency Upsweep Recording, Specimen 2, Z-axis

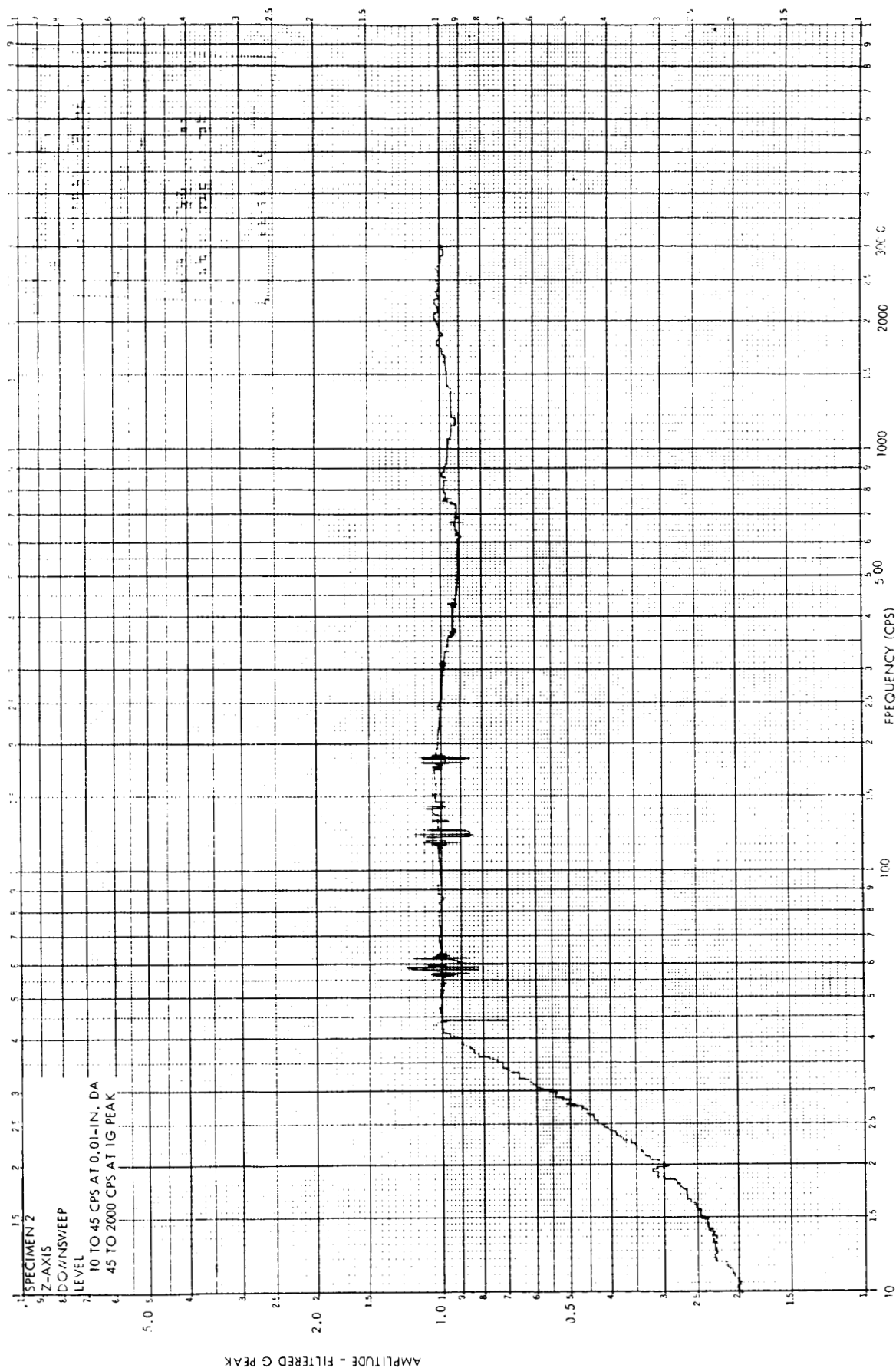


Figure 6-15. Resonant Frequency Downsweep Recording, Specimen 2, Z-axis

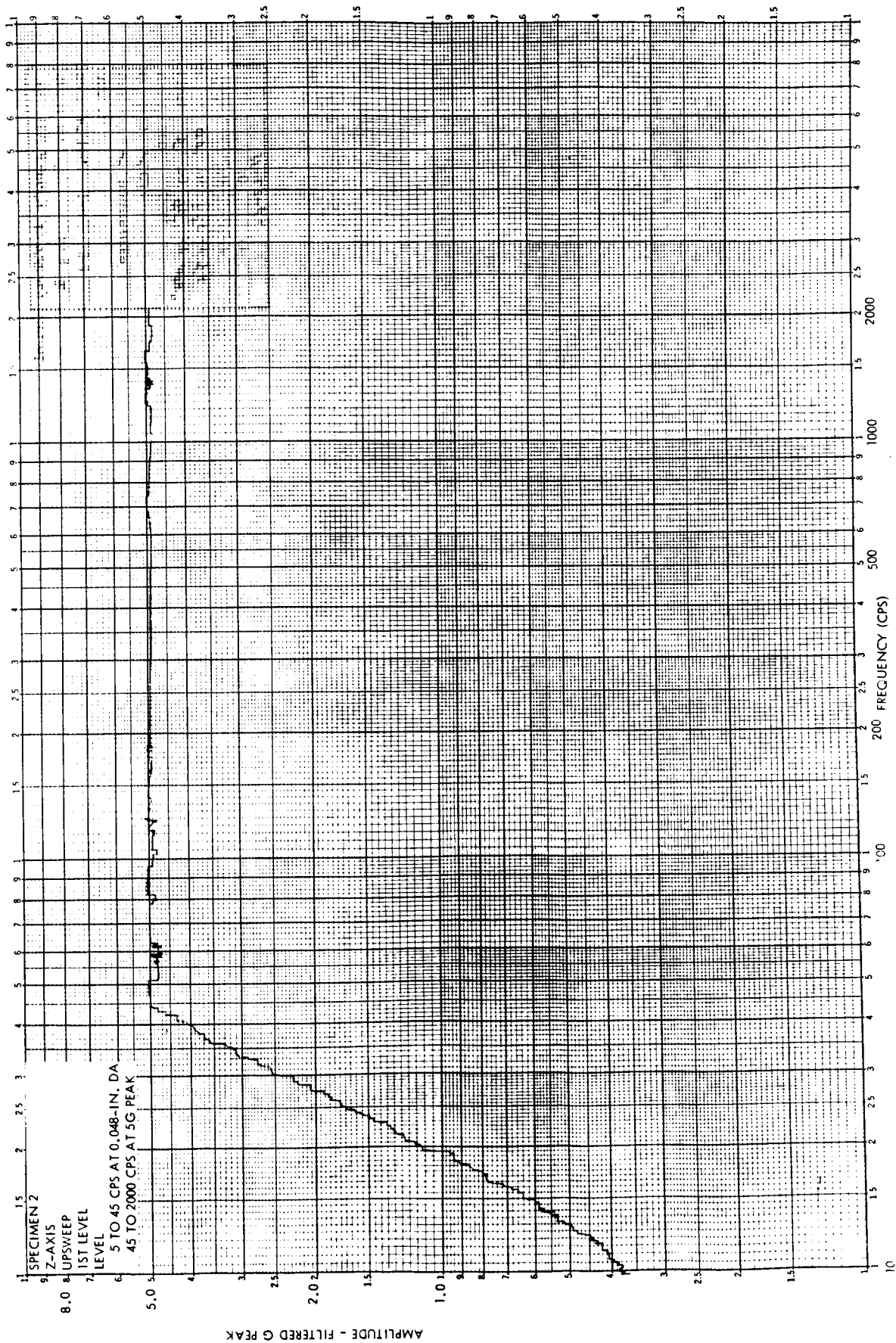


Figure 6-16. Sinusoidal Upsweep Recording, Specimen 2, Z-Axis

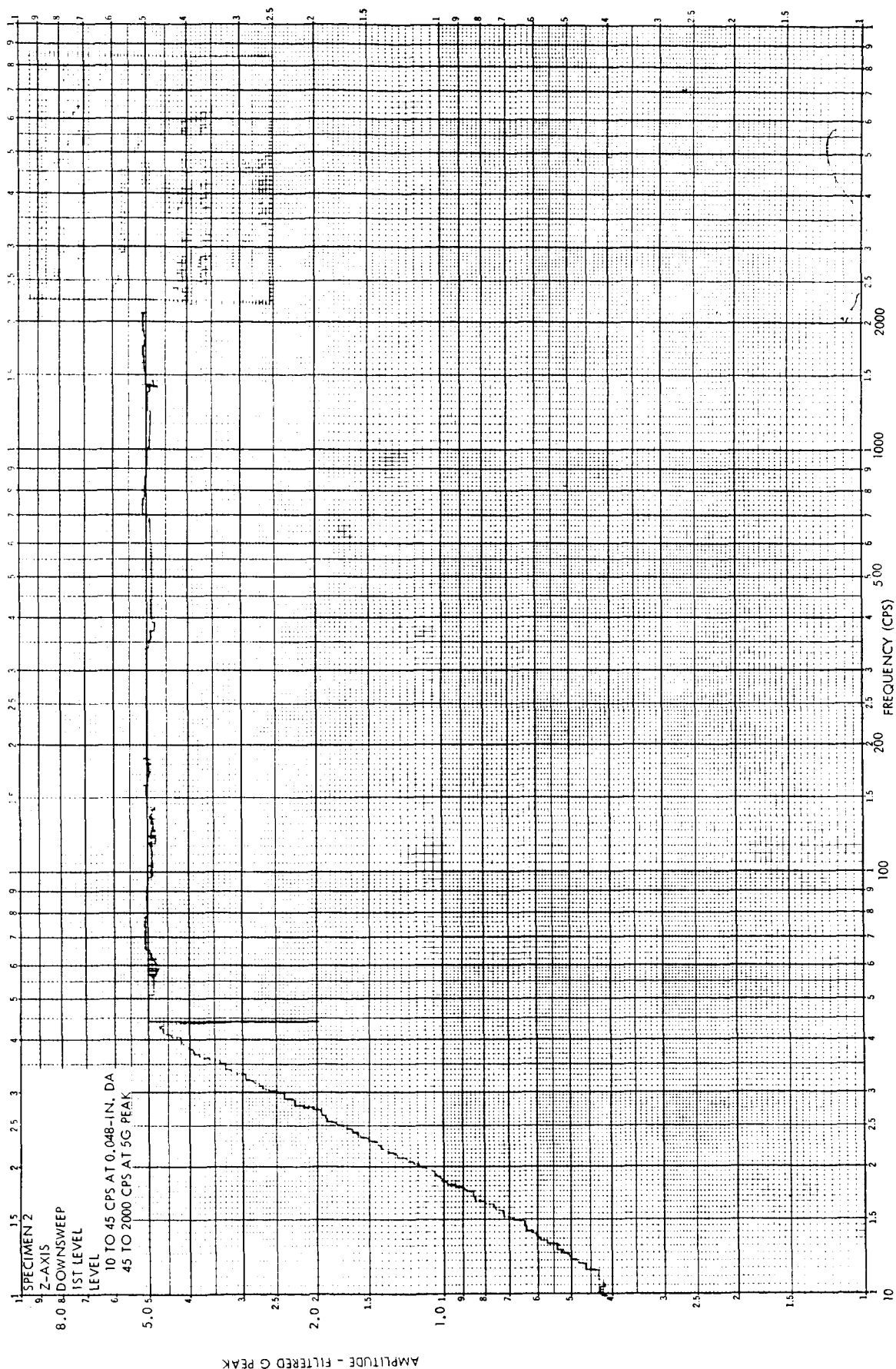


Figure 6-17. Sinusoidal Downsweep Recording, Specimen 2, 2-axis



Figure 6-18. Random Vibration Recording,  
Specimen 2, Z-Axis

## SECTION VII

### SURGE TEST

#### 7.1 TEST REQUIREMENTS

7.1.1 The valve specimen shall be held in the closed position with GN<sub>2</sub> at 750 psig applied to the actuator. The valve specimen inlet shall be pressurized from zero to 300 psig with LN<sub>2</sub> as the pressure medium within 100 milliseconds. The specimen shall be subjected to 1000 cycles.

7.1.2 A functional test, as specified in 4.2.5.1 through 4.2.5.4, shall be conducted after 500 and 1000 cycles.

#### 7.2 TEST PROCEDURE

7.2.1 The surge test setup was assembled as shown in figures 7-1 and 7-2 utilizing the equipment listed in table 7-1.

7.2.2 Hand valves 6 and 7 were opened and regulator 5 was adjusted to provide 750 psig to the actuator to hold the test specimen in the closed position.

7.2.3 Hand valve 14 and solenoid valves 15 and 16 were opened and LN<sub>2</sub> was allowed to flow through the test specimen inlet until stabilization of the specimen temperature occurred.

7.2.4 Solenoid valves 15 and 16 were opened and closed alternately to provide a pressure surge of zero to 300 psig at the test specimen inlet. Hand valve 14 was adjusted to provide a pressure rise time of 100 milliseconds.

7.2.5 1000 surge cycles were performed. After 500 and 1000 cycles, a functional test was performed as specified in 4.2.5.1 through 4.2.5.4.

#### 7.3 TEST RESULTS

The results of the surge test and follow-up functional test were satisfactory.

#### 7.4 TEST DATA

Functional test data obtained after the surge test are presented in table 7-2. A typical surge waveform, as recorded during this test, is presented in figure 7-3.

Table 7-1. Surge Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Hadley Valve Co.	11953-6	2	Butterfly valve, 6-inch, 300-psig
2	Hand Valve*	Hoke	NA	NA	1/4-inch
3	Press. Gage*	Ashcroft	NA	NA	0-to 5500-psig Cal. date 9/6/66
4	Filter	Bendix	1731260	570015	
5	Pressure Regulator*	Tescom	NA	NA	
6	Hand Valve*	Hoke	NA	NA	1/4-inch
7	Hand Valve*	Hoke	NA	NA	1/4-inch
8	Pressure Gage*	Heise	NA	NA	0-to 3500-psig Cal. date 9/6/66
9	Switch*	Minneapolis-Honeywell	NA	NA	SPST
10	Switch*	Minneapolis-Honeywell	NA	NA	SPST
11	Indicator Panel	CCSD	NA	NA	
12	Solenoid Valve	Marotta	MV-74	17747	2-position, 3-way
13	Solenoid Valve	Marotta	MV-74	17745	2-position, 3-way
14	Hand Valve	Flowmatics, Inc.	NA	2581	1/2-inch cryogenic
15	Solenoid Valve	Ansco	WP-8268-122T	70335N	2-position, 2-way
16	Solenoid Valve	Ansco	WP-8268-122T	86376N	2-position, 2-way
17	Pressure Transducer	Consolidated Electrodynamics Corp.	NA	2471	0-to 500-psia Cal. date 8/20/66

\* This part is a component of cryogenic test console 200586 (NASA special equipment).

Table 7-1. Surge Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
18	Oscillograph	Consolidated Electrodynamics Corp.  G. C. Wilson and Co.	124	NASA 012586	
19	Relay		NA	NA	
20	Repeat Cycle Timer		NA	019618	
21	Counter		NA	BT 200- 616-A	
22	Power Supply		NA	NA	
23	Power Supply		NA	NA	
24	Power Supply		NA	NA	
25	GN <sub>2</sub> Source		NA	NA	
26	LN <sub>2</sub> Source		NA	NA	

Note: Manufacturer, Model/Part Number, and Serial Number columns shall be completed during the test.

Table 7-2. Functional Test Data (Post Surge)

No. of Cycles	500	1000
Valve Seat Leakage (sccm)	196	49
Valve Response Time (ms) Open	358	352
Close	345	343
External Leakage	None	None
Loss of Actuator Pressure Response (ms)	280	225

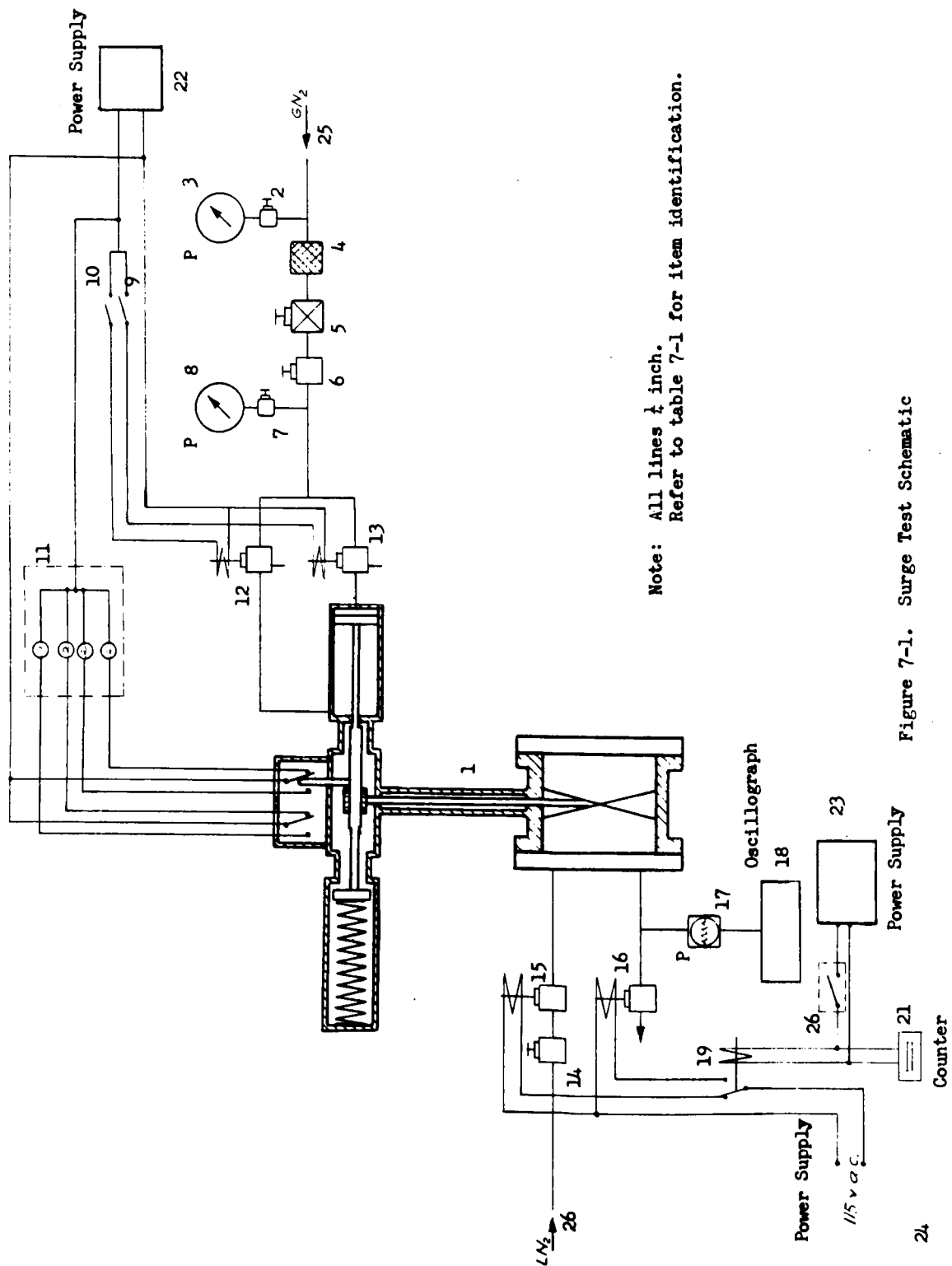


Figure 7-1. Surge Test Schematic

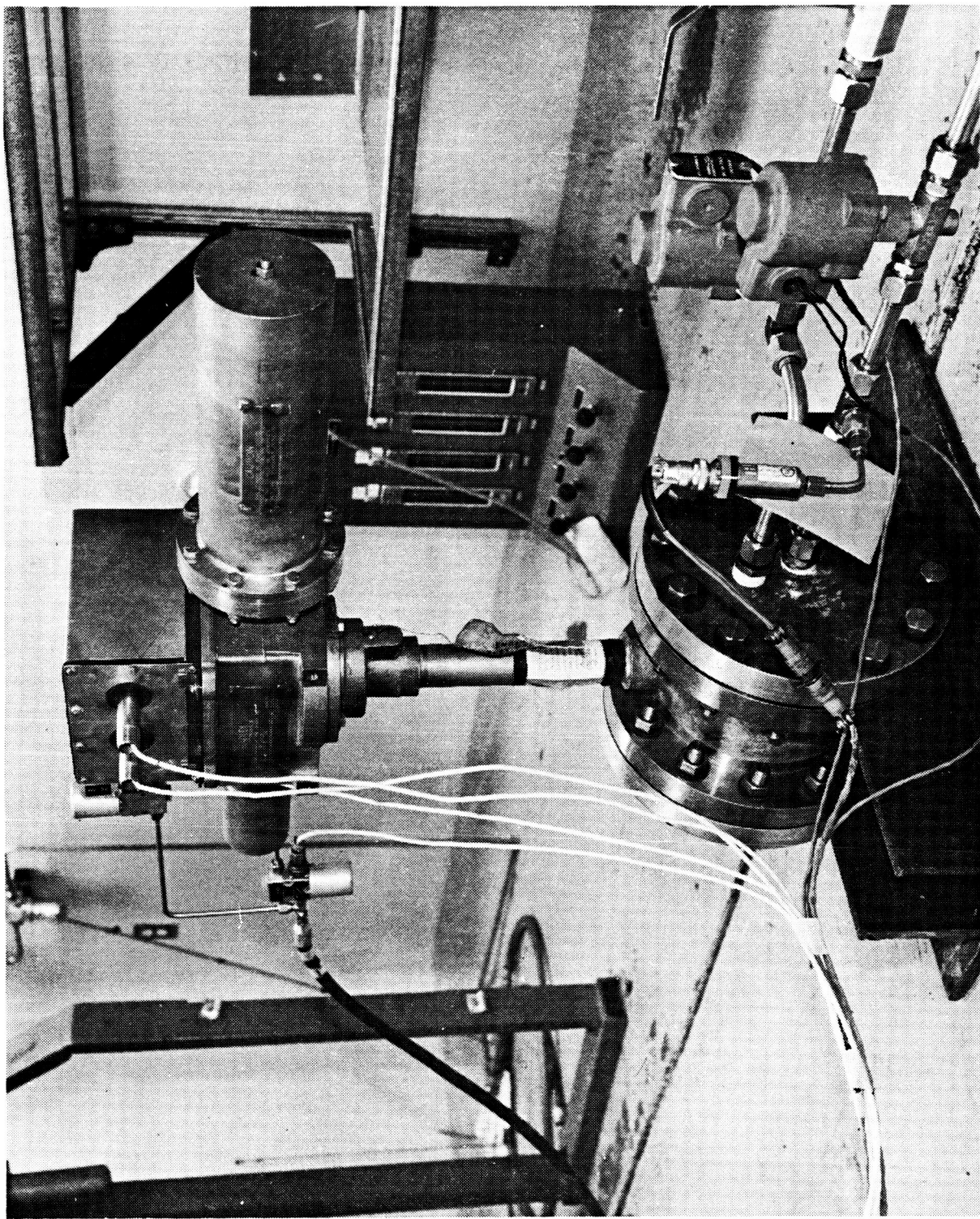


Figure 7-2. Surge Test Setup

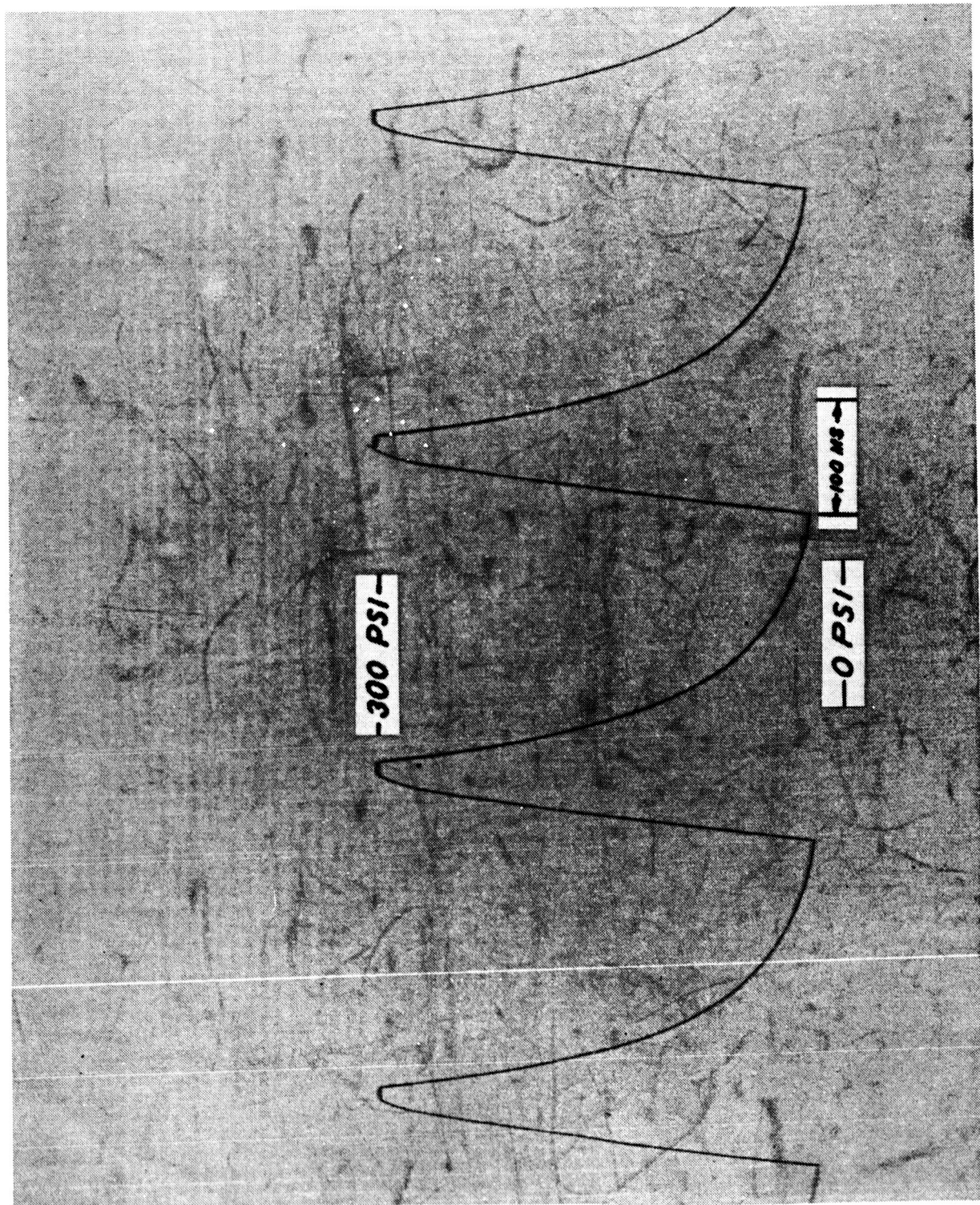


Figure 7-3. Surge Waveform

## SECTION VIII

### ICING TEST

#### 8.1 TEST REQUIREMENTS

- 8.1.1 An icing test shall be performed to determine the ability of the test specimen to perform under icing conditions.
- 8.1.2 The icing test shall be performed in accordance with section 14 of KSC-STD-164(D).
- 8.1.3 The temperature in the test chamber shall be regulated and maintained at 5°F.
- 8.1.4 Spray nozzles, located at a minimum distance of 2 feet from the test specimen, shall emit water into the test chamber in droplets having a minimum diameter of 1.5 millimeters.
- 8.1.5 Water which has been precooled to 40°F shall flow through each spray nozzle at a rate of approximately 2 gallons per minute.
- 8.1.6 Functional tests shall be performed during and after the icing test.

#### 8.2 TEST PROCEDURE

- 8.2.1 The test specimen was installed as shown in figures 8-1 and 8-2.
- 8.2.2 Temperature within the chamber was reduced to 5°F and hand valves 16 and 17 were opened to allow LN<sub>2</sub> to flow through the specimen.
- 8.2.3 When stabilization of the chamber temperature occurred, water at 40°F was injected into the test chamber. Injection of the water was continued until a minimum of  $\frac{1}{2}$  inch of ice had formed on the test specimen.
- 8.2.4 A functional test was performed as specified in 4.2.5.1, 4.2.5.2, and 4.2.5.4.
- 8.2.5 The temperature within the test chamber was returned to room ambient conditions.
- 8.2.6 Within 1 hour after completion of the icing test, the test specimen was inspected for the formation of ice on moving parts and a functional test was performed as specified in paragraphs 4.2.5.1 through 4.2.6.

#### 8.3 TEST RESULTS

The results of the icing test and follow-up functional test were satisfactory.

TEST DATA

Functional test data obtained during and after the icing test are presented in table 8-2.

Table 8-1. Icing Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Hadley Valve Co.	11953-6	2	Butterfly valve, 6-inch, 300-psig
2	Hand Valve*	Hoke	NA	NA	1/4-inch
3	Pressure Gage*	Ashcroft	NA	NA	0-to 5500-psig Cal. date 9/6/66
4	Filter	Bendix	NA	NA	
5	Pressure Regulator*		NA	NA	
6	Hand Valve*	Hoke	NA	NA	1/4-inch
7	Hand Valve*	Hoke	NA	NA	1/4-inch
8	Pressure Gage*	Heise	NA	NA	0-to 3500-psig Cal. date 9/6/66
9	Switch*	Minneapolis Honeywell	NA	NA	SPST
10	Switch*	Minneapolis- Honeywell	NA	NA	SPST
11	Timer*	Standard Electric Time Co.	NA	NA	
12	Solenoid Valve	Marotta	MV-74	17747	2-position, 3-way
13	Solenoid Valve	Marotta	MV-74	17745	2-position, 3-way
14	Flowmeter	Fisher Porter	N/A	200 595 E thru H	
15	Relief Valve	Anderson Green- wood	N/A	23645	1-inch cryogenic
16	Hand Valve	Flowmatics, Inc.	N/A	2581	1/2-inch cry- ogenic

\* This part is a component of cryogenic test console 200586 (NASA special equipment).

Table 8-1. Icing Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
17	Hand Valve	Hydromatics	NA	6121B	1/2-inch cryogenic
18	Power Supply		NA	NA	28-vdc
19	GN <sub>2</sub> Supply		NA	NA	
20	LN <sub>2</sub> Supply		NA	NA	

Table 8-2. Functional Test Data Obtained During and After Icing Test

Test Chamber Conditions	Icing	Room Temperature
Valve Seat Leakage (sccm)	0	0
Valve Response Time (ms) Open	350	270
Close	343	258
External Leakage	—	None
Loss of Actuator Pressure Response (ms)	1725	1870
Insulation Resistance (meg)	—	20,000 min.



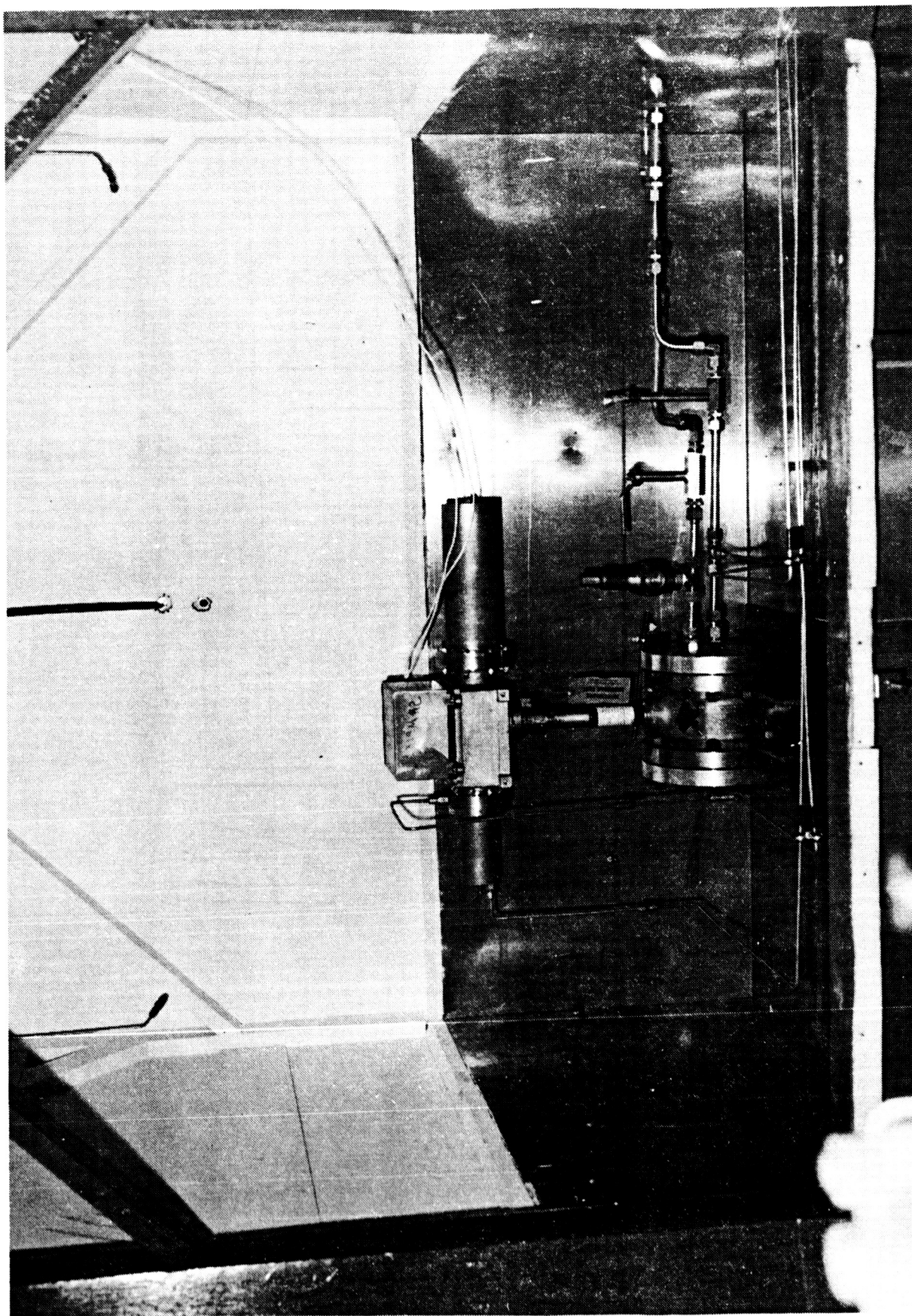


Figure 8-2. Icing Test Setup

## SECTION IX

### SALT FOG TEST

#### 9.1 TEST REQUIREMENTS

- 9.1.1 The salt fog test shall be performed to determine the resistance of the test specimen to a salt atmosphere.
- 9.1.2 The salt fog test shall be performed in accordance with section 17 of KSC-STD-164(D).
- 9.1.3 The test specimen shall be exposed to the salt fog for 240 (+2) hours. All ports of the test specimen shall be capped during exposure to the salt atmosphere.
- 9.1.4 A functional test shall be performed upon completion of the salt fog test.

#### 9.2 TEST PROCEDURE

- 9.2.1 The test specimen was visually inspected for corrosion, dirt, and oily films prior to the salt fog test. The test specimen was placed in a salt fog chamber as shown in figure 9-1.
- 9.2.2 The temperature in the chamber was maintained at 95 (+2, -4)°F. The salt fog conditions in the chamber were maintained such that a clean fog-collecting receptacle placed at any point within the exposure zone would collect from 0.5 to 3 milliliters of salt solution per hour for each 80 square centimeters of horizontal collecting area (10 centimeters diameter), based on an average test of at least 16 hours. The salt solution consisted of five parts by weight of sodium chloride and 95 parts by weight of water.
- 9.2.3 The test specimen was exposed to the salt fog conditions for 240 (+2) hours.
- 9.2.4 Upon completion of the test the specimen was removed from the chamber and salt deposits were removed to the extent necessary for mechanical connections to be made. Within 1 hour after completion of the exposure period, a functional test as specified in 4.2.5.1 through 4.2.6 was performed.

#### 9.3 TEST RESULTS

Upon completion of the salt fog test, some rust and corrosion were found on the outer surfaces of the specimen as shown in figure 9-2. However, the performance of the test specimen was not impaired and the salt fog test results are considered satisfactory.

#### 9.4 TEST DATA

Functional test data obtained after the salt fog test are presented in table 9-1.

Table 9-1. Functional Test Data (Post Salt Fog)

Valve Seat Leakage (sccm)	0
Valve Response Time (ms) Open	365
Close	345
External Leakage	None
Loss of Actuator Pressure Response (ms)	1830
Insulation Resistance (megohm)	1000 min.

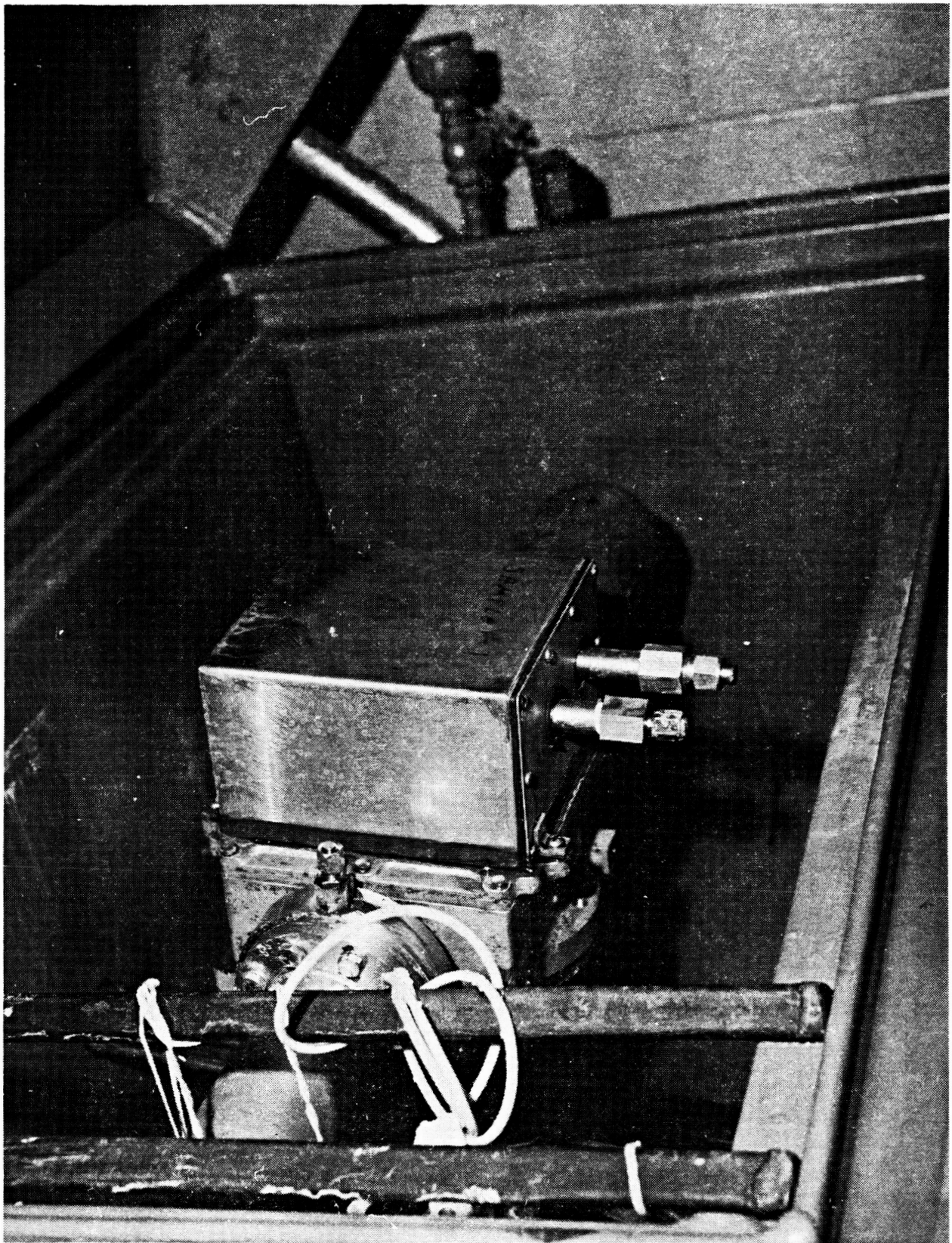


Figure 9-1. Salt Fog Test Setup

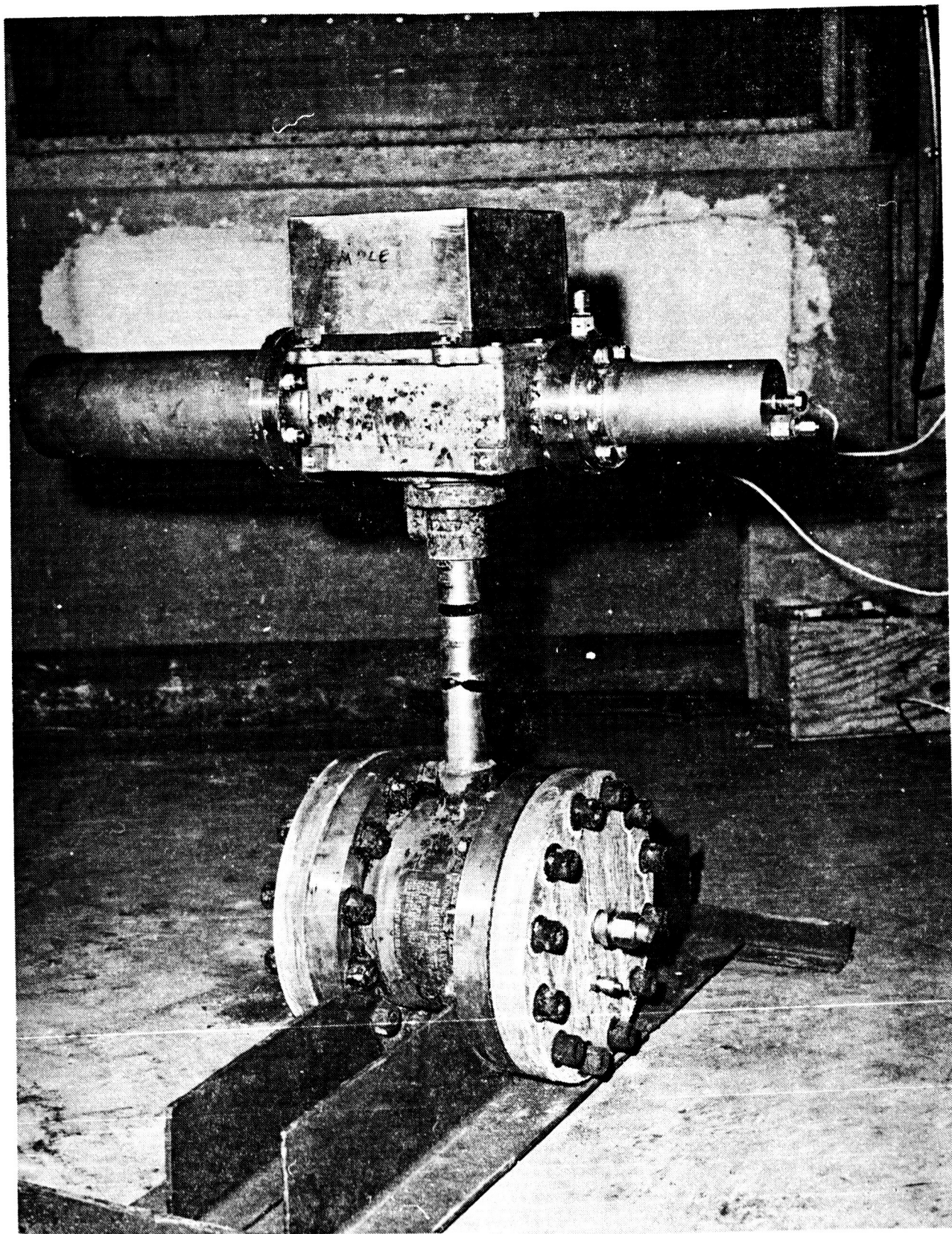


Figure 9-2. Test Specimen After Exposure to Salt Fog Conditions

## SECTION X

### CYCLE TEST

#### 10.1 TEST REQUIREMENTS

- 10.1.1 The test specimen shall be subjected to 1000 open-close cycles to determine whether the environment causes degradation or deformation.
- 10.1.2 The test medium used for the cycle test shall be LN<sub>2</sub> at -320°F.
- 10.1.3 A functional test in accordance with section IV shall be performed after 100, 500, and 1000 cycles.

#### 10.2 TEST PROCEDURE

- 10.2.1 The cycle test setup was assembled as shown in figures 10-1 and 10-2 utilizing the equipment listed in table 10-1.
- 10.2.2 Hand valve 6 was opened, regulator 5 was adjusted to provide 750 psig to the actuator, and solenoid valves 12 and 13 were energized to place the test specimen in the opened position.
- 10.2.3 LN<sub>2</sub> at 300 psig was provided to the test specimen inlet and hand valve 15 was partially opened to allow LN<sub>2</sub> to flow through the test specimen.
- 10.2.4 When the specimen temperature stabilized, the specimen was closed by de-energizing solenoid valves 12 and 13 and then opened by energizing solenoid valves 12 and 13. This constituted one cycle.
- 10.2.5 The test specimen was subjected to 1000 cycles. A functional test as specified in 4.2.5.1 through 4.2.5.4 was performed after 100, 500, and 1000 cycles.

#### 10.3 TEST RESULTS

The results of the cycle test were satisfactory.

#### 10.4 TEST DATA

Functional test data obtained during the cycle test are presented in table 10-2.

Table 10-1. Cycle Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Hadley Valve Co.	11953-6	1 and 2	Butterfly valve, 6-inch, 300-psig
2	Hand Valve*	Hoke	NA	NA	1/4-inch
3	Pressure Gage*	Ashcroft	NA	NA	0-to 5500-psig Cal. date 9/6/66
4	Filter	Bendix	NA	NA	
5	Pressure Regulator*	Tescom	NA	NA	
6	Hand Valve*	Hoke	NA	NA	1/4-inch
7	Hand Valve*	Hoke	NA	NA	1/4-inch
8	Pressure Gage*	Heise	NA	NA	0-to 3500-psig
9	Timer	G. C. Wilson and Co.	NA	019618	
10	Indicator Panel	CCSD	NA	NA	
11	Counter		NA	BT 200616-A	
12	Solenoid Valve	Marotta	NA	17747	2-position, 3-way
13	Solenoid Valve	Marotta	NA	17745	2-position, 3-way
14	Relief Valve	Anderson Greenwood	NA	23645	1/2-inch cryogenic
15	Hand Valve	Flowmatics	NA	2581	1/2-inch cryogenic
16	Power Supply		NA	NA	28-vdc
17	GN <sub>2</sub> Supply		NA	NA	
18	LN <sub>2</sub> Supply		NA	NA	

\* This part is a component of cryogenic test console 200586 (NASA special equipment).

Table 10-2. Life Cycle Functional Test Data

Specimen No.	1			2		
No. of Cycles	100	500	1000	100	500	1000
Valve Seat Leakage (sccm)	0	0	0	0	0	0
Valve Response Time (ms)	Open	315	318	320	375	268
	Close	290	311	305	270	265
External Leakage	None	None	None	None	None	None
Loss of Actuator Press.-Response (ms)	2650	1820	1645	1875	1890	1894



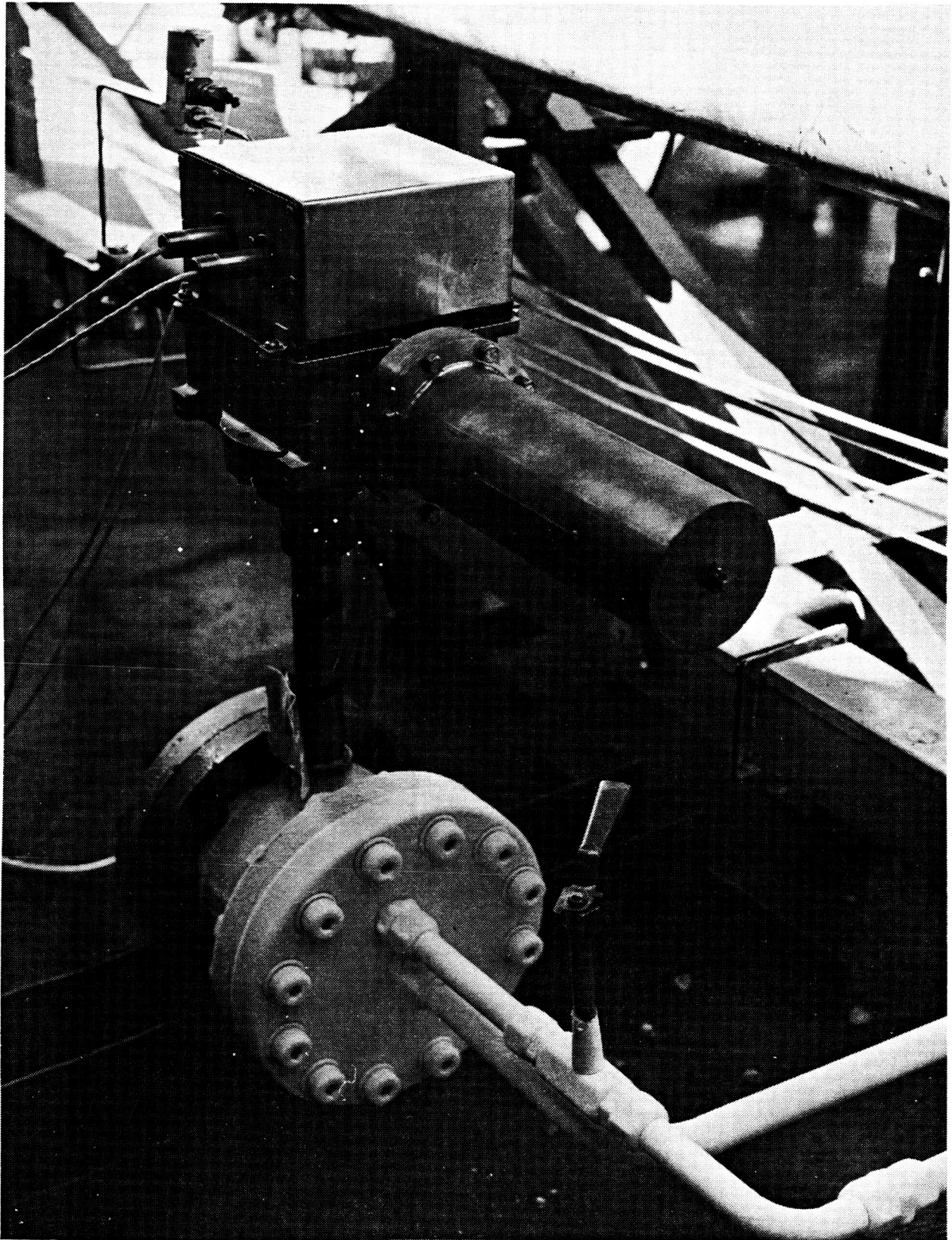


Figure 10-2. Cycle Test Setup

APPROVAL

TEST REPORT


FOR

BUTTERFLY VALVE, 6-INCH, 300-PSIG

Hadley Valve Company Model Number 11953-6


NASA Drawing Number 75M13141 LSOV-2

SUBMITTED BY:

  
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